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OPENING CIRCUITS CARRYING LARGE POWERS AND HIGH VOLTAGES.

With the continual concentration of greater and greater powers in central generating stations, the problems of controlling the enormous electrical loads, especially in times of emergency, have become more and more troublesome. The opening of a circuit carrying a heavy railway load, for example, is accompanied by manifestations of almost explosive violence, especially if the line opened is very heavily loaded or short-circuited and the supply is derived from a bank of large generators. With the much higher voltages obtained with alternating currents and the modern machines of this type built for close regulation, and consequently able to give many times their rated load before their fields are killed by the armature reaction, and mounted directly, as they now are, on the engine shafts, with fly-wheels weighing many scores of tons rigidly coupled to the rotating part, the problem of opening a circuit in case of emergency is no light one.

Fuses of the ordinary lead alloy are quite out of the question for such work, and for very heavy loads no satisfactory fuse has as yet been found. Aluminum is now coming into wide use in such work in preference to the ordinary fusible metal, owing largely to its greater conductivity and consequent reduced cross-section for the same load, which gives a much smaller amount of melted or volatilized metal, a higher resistance for the arc that tends to follow fusing, and less discoloration and destruction of the cut-out base and contacts. Enclosed fuses—that is, those with a fusible wire packed in a powder of some material which absorbs the heated metal and in certain cases forms with it an insulating, vitreous mass,—are in some use, in one instance on circuits carrying 20,000 volts. But these only serve for comparatively light loads, the enormous concentration of power on the cut-out of a circuit designed with a reactance sufficiently low for carrying many thousand kilowatts, in case of dead short-circuit with an ample generating capacity behind it, practically precluding the use of anything as yet designed in the nature of a fuse.

Switches for such work are generally made of the knife-blade type, with a quick-acting spring-operated break following the opening of the main contact. The object, of course, of a quick-opening switch is to break the arc before it has time to heat its terminals to the fusing point, when the melted metal would allow the arc to persist. Its action greatly assists the opening of non-inductive circuits, but it is dangerous in cases of high inductance, either in direct or alternating current work. No sensible engineer would dream of operating such a switch in the field circuit of a shunt-wound machine. The stored energy of magnetization must find a vent as the field current dies down, and the more rapidly the circuit is opened the longer will be the arc through which the current will follow, with a correspondingly higher strain of the insulation. Somewhat similar conditions exist in alternating-current circuits, especially with the iron of many transformers or motors interlinked with the circuit. A quick break sets up high inductive electromotive forces which, with the capacity of underground cables, may, and often do, set up dangerous oscillations. The remedy used in the case of field circuits is to shunt the inductive winding with a path of about the same resistance before opening its supply. A similar procedure in alternating-current work may prove valuable.

The devices designed during the last few years for breaking heavy high-voltage alternating loads are quite numerous. The switches used on the great Niagara generators, with their sixteen secondary or "follower" breaks of non-arcing metal—the primary break inserting a considerable resistance—are well known. With higher voltages even these do not seem to work satisfactorily. Plunger-type switches are quite generally used, the break being effected in the middle of a space confined by a chamber of porcelain, or some hard wood, such as lignum vitæ or apple wood, in which the heat generated by the arc blows the arc itself out. Another type, described in the article on another page on the Brooklyn Edison system, breaks the circuit under oil, and this practice seems to be finding favor. Even this, however, with twelve breaks in the circuit, does not suffice in the case of this central station, and an emergency switch is provided, consisting of simple knife-blades shunted by long, fine copper wires in fibre tubes, which take the arc from the switch when it is opened and blow themselves into vapor with such violence as to prevent the continuance of the arc after their own fusing. So-called "tank" switches have been used somewhat and always with great success, although they are rather unscientific pieces of apparatus. They consist fundamentally of a metal tank holding water, into which a long conducting rod, preferably of carbon, may be lowered. Touching the bottom of the tank, the circuit is a fairly satisfactory one for very high voltages, and may be rendered more so by shunting it with any suitable form of switch. To open the line this switch is, of course, first opened and the rod is raised through and from the water. The resistance of the water cuts down the load considerably before the carbon rod leaves its surface, and any arc which follows does no harm either to the rod or the water.

Such clumsy pieces of apparatus, however, cannot be satisfactorily embodied in automatic circuit-breakers, which are further handicapped in alternating-current work by the unsuitable character of magnetic blow-outs for this style of current. Secondary breaks of carbon, with a very wide opening, approaching in some equipments now in service five or six feet, seem to be the most satisfactory solution so far devised. Air-blasts apparently offer another solution which, if tried, has not as yet been put into commercial use, and breaking under oil may prove as satisfactory for automatic overload breakers as for switches, although, of course, overload breakers, as a rule, have the heavier service of the two.

A REQUIREMENT OF ELECTRICAL HEATING APPARATUS.

That electrical heating has a wide field of usefulness in spite of its considerable cost per British thermal unit no one can now deny. There are many places where "the best is none too good," regardless of expense, and electrical methods of heating are undoubtedly the best. In spite also of its high cost per thermal unit the heat so developed can be made much more effective in local applications than that developed by such a crude piece of apparatus as, for example, a cooking range. Cooking processes, it should be noted, are not essentially endothermic and do not in themselves require the delivery of much, if any, energy. It is only, as a rule, the waste or external radiation that must be provided for, the cooking requiring simply that its ingredients be maintained at a certain temperature difference above that of surrounding objects. The whole secret, therefore, of economy in electrical cooking is protection against loss. If the radiation of an electrical oven, for example, can be reduced 90 per cent. by careful lagging, the current necessary for operating that oven will be reduced in the same proportion. Electrical heaters for raising the temperature of water, however, and particularly air heaters, are not subject to this possible economy, and no improvements can be expected of them in this respect, their transforming efficiency being, of course, in all cases 100 per cent., although that of cooking apparatus may, by the reasoning given above, be considered 0 per cent.

The greatest limitation of electrical heating, however, is perhaps the danger of burnouts. An electrical sad-iron capable of maintaining its proper temperature when run rapidly, as it is in regular service, over moistened cloth, is certain, if left on the cloth with the current on, to start a fire. An electrical urn, teakettle or coffee pot, if capable of heating its contents to the boiling point in a reasonable length of time, will invariably burn out if it boils dry. If there is one thing that the average kitchen attendant may be depended upon to do it is to forget to turn the power off. What is needed to prevent accidents under this condition is the use of a resisting element with a very high temperature coefficient, and preferably a temperature coefficient turning up sharply at about the temperature at which it is intended to be worked. Automatic thermostats might, of course, be incorporated, but are much more suitable for laboratory than for kitchen work.

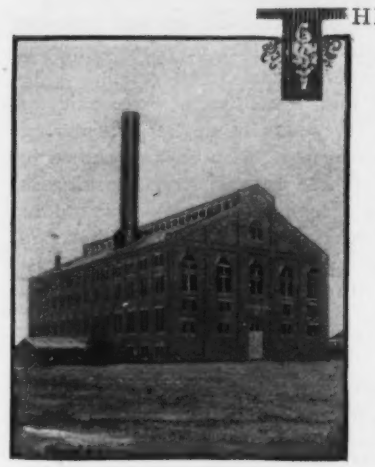
In a recent issue of "L'Eclairage Electrique" a new French electric heating system was described, its chief novelty being the use of silicon rods as the resisting medium. These are inclosed in glass tubes, which in turn are exhausted to prevent oxidation, the temperature of the rod being carried up to about 700° or 800° C. The high specific resistance of the material eliminates the necessity of long fine wires, and its ability to withstand a high temperature allows a far greater radiation from the same area, and these points are considered great advantages. In this country we prefer a considerable area of comparatively low temperature for air-heating purposes, as it gives much gentler currents of moderately warmed air in place of the fierce draughts of air highly heated which rise straight to the ceiling and are of little value. For the heating of liquids the resisting material should be in such intimate contact with the liquid surface that its temperature could not rise much above that of the boiling point under any condition, and metallic resistances will withstand this temperature just as well as more refractory materials. The silicon has also a temperature coefficient just the reverse of what is needed, its resistance at 800° C. being only about two-thirds of that when it is cold; in other words, the hotter it gets the more power it takes and the more it tends to still further increase in temperature and still further lower in resistance. Metals and their alloys have the proper tendency in this respect, although common ones do not possess it to a sufficiently great degree to make it of much service. The discovery of a material which would and which possessed the other requirements for this duty would be a valuable one.

Frequencies in England.

The urgent need for the standardization of frequencies is shown in a catalogue recently issued by the Langdon-Davies Electric Motor Company, in which is given a table of the frequencies of seventy-seven different alternating-current systems in England. The number of plants operating at the various different frequencies is given below:

Frequencies.	No. of Plants.	Frequencies.	No. of Plants.
40	3	80	3
50	13	83	8
50 and 100	1	83.5	2
53	1	85	1
60	8	86	1
67	1	87	1
68	1	90	1
70	2	93	2
75	3	100	22
75 to 80	1	125	1
77	1		

The New Work of the Brooklyn Edison Company.



THE now well-defined tendency of electric lighting work in the large cities is toward central generating stations removed from the centre of distribution to positions of greater convenience, with high-tension transmission and transforming sub-stations. In this work the Edison Electric Illuminating Company, of Brooklyn, is recognized as a leader and a pioneer in much of the original development. This company, which has now been absorbed by the Kings County Electric Light & Power Company, recognizing the tendency of best practice, boldly set out on the installation of a 6000-volt high-tension system, with all the improvements that would apparently add to the efficient and economical working of the plant. The details of many of these were not as yet standardized, and difficulties have naturally been encountered, with results that are of the greatest interest to others contemplating a similar procedure. There is given below a very brief account of the main points of the system, the interesting features being described in greater detail.

The main generating station is located at Bay Ridge, and a fair idea of the general layout can be obtained by an examination of the accompanying sectional elevation given in Fig. 2. The design is intended for a minimum amount of attendance and a maximum economy of steam. The details by which these features are obtained are given below.

A coal conveyor is, of course, used, and this part of the installation contains some novelties. The coal is removed from canal boats on the water front by motor-driven buckets hung from a boom on a movable tower, also motor-driven, these buckets dumping into one of two cars connected to each other by a steel wire cable, the one under the discharge bucket when fully loaded closing a circuit automatically and starting up a motor which sets the cable in motion, running the car up an incline above a 2500-ton bin and sending the other car down to take its turn. It is well to note that all auxiliaries of this station are motor-driven by direct-current, 220-volt motors. From under the hopper of this 2500-ton bin a regular link-belt conveyor carries coal up an incline, dumping into a V-shaped pocket (see the illustration) above the boiler room, holding about a three days' supply. Automatic recording weighing chutes from this discharge into horizontal channels along the boiler fronts just above the fire doors, the coal being distributed along these channels from the outlets of the weighing chutes to the furnaces by means of rotating screws. From these it drops into steam-driven American stokers, this part of the equipment being previously described in these columns.* Mixed soft coal slack and anthracite are burned.

There are now five triple-drum water-tubular boilers in place, supplying steam to the two main engines. The smaller of these is a Hamilton-Corliss cross-compound horizontal, with a 750-kw G. E. three-phase, 6600-volt generator mounted with the fly-wheel between the main journals. The generator itself is of the revolving field type and is protected from flying oil by means of a sheet brass shield on the side toward the engine. Beside this stands the larger and far more interesting unit, which at the time of its construction was one of the largest ever built, but is already no longer the standard for the rest of the station, which will be equipped with vertical cross-compound engines of 5000 horse-power and 3500-kw dynamos. The unit now in service consists of a McIntosh & Seymour horizontal twin-tandem compound rated at 3000 horse-power, but with a large overload margin, and driving a G. E. 25-cycle, 6600-volt, three-phase generator rated at 1500 kilowatts on a 5 per cent. regulation drop, but also with a large overload capacity and commonly worked at about 2000 kilowatts.

Near the high pressure cylinder heads of this engine stand two small G. E. single-cylinder, high-speed vertical engines coupled to direct-current dynamos used temporarily for exciting purposes. Exciting current and power for the auxiliaries is also derived from two 100-kw Edison multipolars coupled to the ends of the shaft of an Erie marine-type triple-expansion engine, this unit standing near a small auxiliary switchboard on which it is controlled by magnetic switches energized from the main switchboard.

The engines all stand at the west end of the station, a long dis-

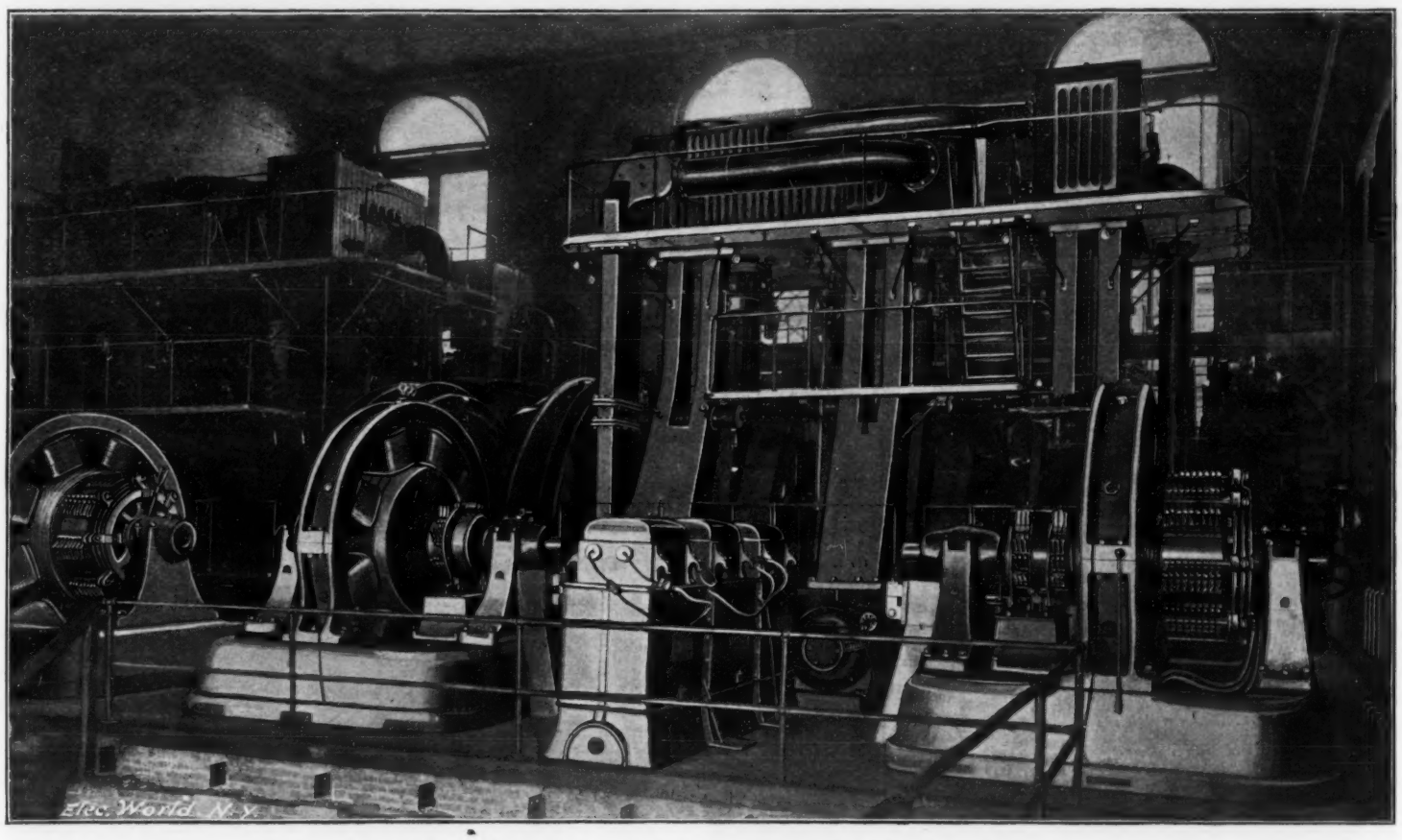


FIG. 1.—THREE OF THE FOUR ROTARIES IN THE PEARL STREET STATION.

* See THE ELECTRICAL WORLD, October 8, 1898, page 377.

tance from the electrical gallery, which is at the extreme east end, the intermediate space to be filled later by six generating units, which will give the plant a capacity of about 34,000 horse-power, which can be quadrupled by extensions of the structure.

In the high basement where the coming units will stand a small space is now occupied by a 100-kw synchronous motor temporarily coupled to two bipolar Edison generators, which can also be used for excitation and auxiliary purposes. Further reserve direct current for use instead of the steam-driven exciters will be provided by a small storage battery and booster, and a permanent equipment consisting of two 100-kw synchronous motors, each coupled to a multipolar direct-current generator. In the rest of the basement under the boilers and engines are the various direct-geared motor-driven auxiliaries consisting of boiler-feed pumps and circulating and air pumps for the condensers.

tance. There are in this station three bus bars for each phase at each terminal of the Y combination, in which the generator fields are connected, one intended for high, one for medium and one for low pressure, and either of the main generators may be connected to the buses through an electro-pneumatic oil-break switch.

This switch, which is shown in Fig. 3, consists of three pairs of inverted U-shaped copper strips, the ends of the strips entering contacts mounted under oil contained in wooden buckets shown in the lower part of the illustration. There are two strips working in one bucket at each corner of the three-phase circuit, giving four breaks in each phase or twelve breaks altogether. The U-shaped strips are attached to and are lifted by a cross-head worked by a piston in the air cylinder shown at the top of the apparatus. This piston is moved by compressed air, in turn controlled by three magnets, one to mechanically latch the switch in either the open or

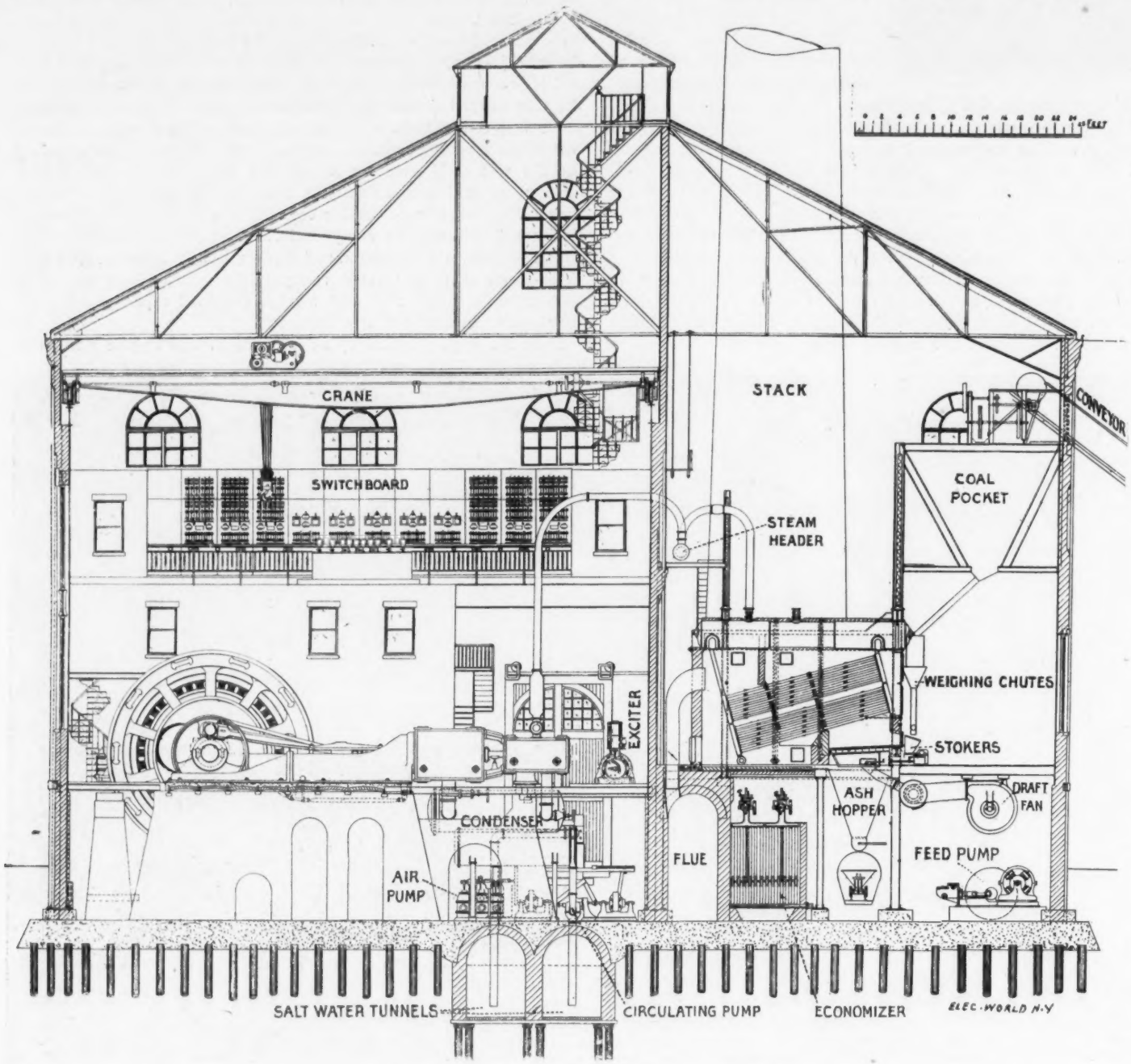


Fig. 2.—The Generating Station in Section.

Climbing to the switchboard gallery a most bewildering array of strange and new types of apparatus is to be seen. Running along the edge of the gallery overlooking the room is a group of field rheostats and instruments for indicating and controlling the direct-current machines. At the other side of the gallery are the main high-tension panels, one being fitted with a large number of plug receptacles and lamps for synchronizing work and a static voltmeter for use as a ground detector. Others have knife switches for high-tension work, making various circuit combinations, and still others dial switches for controlling magnetically other switches at a dis-

closed position and the other two to operate valves which admit air respectively above or below the piston. To eliminate any possibility of arcing on heavy loads two phases of each of these switches are in series with emergency switches, consisting of knife blades, such as those shown in Fig. 4, shunted by a strand of lamp cord, 11 inches long, mounted in a fibre tube on cabinets above the switchboard gallery. When the emergency switch is opened—as it is when heavy loads or shorts must be broken—the circuit is thrown through these fuse wires, which, owing to their small carrying capacity, blow with great violence, thus preventing the arc holding across their ter-

minals. There are four of the electro-pneumatic switches, one, as noted above, between each of the machines and the switchboard system, one of the others being a cross-connecting switch between the high-voltage and the main bus bars, and the other a cross-connecting switch betwen the low-voltage and the main bus bars. The latter two give a means of simultaneously throwing in the three phases in paralleling the machines. The circuit from either one of the dynamos — after passing through the pneumatically operated oil switches and the emergency switches described—runs to a set of what might be called three-throw switches on the face of the board, similar to those shown in Fig. 4. Each phase here has three blades in a compartment or stall isolated from the others by heavy wooden barriers, as shown. The blades are not fitted with handles, but merely have holes into which may be inserted a hook on a stick or long pole, so that they may be operated from a considerable distance.

FIG. 3.—AN ELECTRO-PNEUMATIC SWITCH.

The three blades are electrically connected at their hinges and one of them, when thrown in, connects to the high-voltage bus bar, one to the main bus and one to the low-voltage bus on that phase. The outgoing feeders are fed through similar throw-over arrangements. In this way either machine and any feeder can be connected with any one of the buses, which in turn may or may not be cross connected. The loads may be divided in any way desired between the two machines, and more particularly any feeder—when it becomes desirable to open it under a load—may be transferred to and isolated upon one of the buses, which may finally be cut off from the rest of the system by opening one of the electro-pneumatic oil-break cross-connecting switches, thus avoiding opening any other type of switch under load.

The outgoing feeders are all in duplicate, so that in case of trouble with them no part of the system is shut down. They are supplied from the switchboard as noted above through high-tension switches and also through pull-away fuses, one of which is shown in Fig. 5. These consist of aluminum fuse links held between apple-wood strips and attached to swivelled copper terminals which by means of powerful springs tend to pull the ends of the fuse apart the instant it is softened by heat. The apple-wood cover, which is shown to one side, has a hole through which the escaping gases blow out through the long tubular fibre chimney which fits over it. The whole thing is mounted in a wooden frame and is attached to the circuit by means of heavy knives or blades, which enter clips on the face of the board, so that it may be removed for re-fusing without danger of shock to the manipulator.

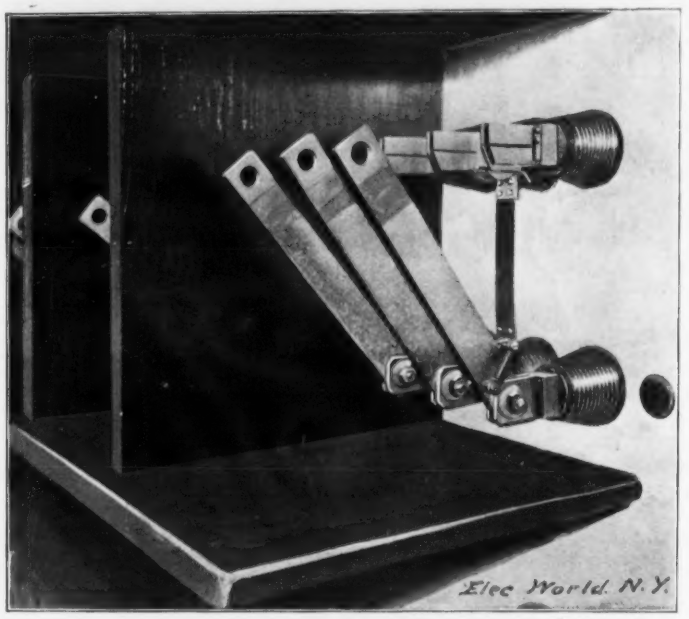


FIG. 4.—THE HIGH-TENSION SWITCHES.

The switchboard contains several other features which appear strange to the eyes of those not versed in this particular line of work, one of them being a set of discharge gaps, looking much like a number of darning needles arranged about the corners of a horizontal equilateral triangle and pointing toward each other, with gaps of seventy-eight-hundredths of an inch between them. These are connected through fuses to the three phases of the circuit and are intended to carry lightning or high-tension oscillatory discharges which may be set up by any abrupt disturbance of the circuit, such as the opening of a switch, and thereby save the insulation. The direct-current exciting dynamos are not connected with main switches on this board, but have a switchboard of their own located near them in the other end of the station. The switches of this board are, however, operated from the main board, and to accomplish this are magnetically controlled. Three of these switches are shown in

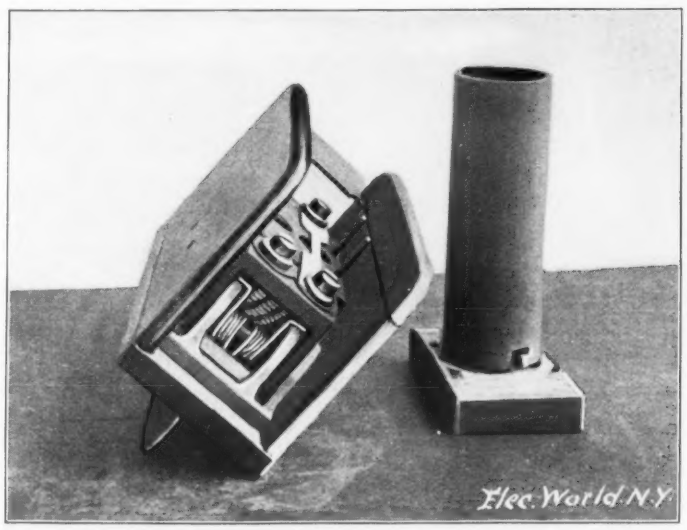


FIG. 5 —ONE OF THE PULL-AWAY FUSES.

FIG. 6.—THREE OF THE MAGNETIC SWITCHES.

Fig. 6. The main contact consists of a large number of thin copper leaves which are pressed against the beveled ends of projecting copper studs, a secondary break being provided on opening by means of carbon contacts spring-supported above the others. The copper and carbon moving parts are hinged on a frame carrying the armature of a heavy electromagnet, the end of the horizontal round core of which appears at the right-hand side of each switch. By energizing this the armature is drawn up and the switch closed. To maintain it in its closed position, however, it is not necessary to leave the current on this magnet, as a long downwardly projecting arm is caught by a trigger at the lower end of the instrument. Another smaller magnet has its armature attached to this trigger, and when energized trips the long arm, allowing the switch above it to open by a spring and gravity.

There are three main feeders running out from the station, consisting of triple-conductor lead-covered cables made by the Standard Underground Cable Company, with paper insulation six thirty-seconds inch thick, a jute filler and three-thirty-seconds of paper inside the one-eighth-inch lead sheath.

SUB-STATION A.

The original station of the Citizens' Electric Illuminating Company, built during the 80's and operated as an arc-light station with Corliss engines, countershafts and a great deal of leather, is now the site of a storage-battery and synchronous-motor sub-station. The main arc-light equipment of this station is shown in Fig. 7, consisting of seven General Electric 6000-volt synchronous motors, each coupled to two 120-light Brush dynamos. These occupy a space of about 4000 square feet as against 32,000, with engine-driven machines, and this will eventually be reduced to 500 square feet by the use of rectifiers.

The motors are four-polar, and therefore with 25-cycle current make 750 r. p. m. They have revolving fields, with laminated poles, and an external stationary armature wound with a heavily insulated three-phase winding distributed in three slots per pole per phase. The motors and generators are all mounted on wooden frames, the construction of one of which, at the extreme left-hand side of the picture, is clearly shown, as there is no machine standing over it. The motors are coupled to the arc-light dynamos by flexible couplings, with the ordinary cylindrical rubber cushions between the interlocked driving and driven spiders. The motors are started, of course, against only a frictional load, and sufficient starting torque is obtained solely by the hysteresial lag of the rotating field in traveling across the wide pole faces of the field magnets, thus giving a sufficient drag to overcome the slight frictional resistance.

To prevent too great a rush of current in starting there is connected in the alternating circuit a set of three reactance coils mounted in a wooden box under one of the couplings between the motor and one of the dynamos. These three reactive coils are in circuit on starting, and are short-circuited as the machine speed rises, giving sufficient torque to bring it up to synchronism when it runs for a moment as a synchronous motor with a field excited by lagging currents, until direct current is turned into the field windings to give the necessary field excitation.

The machines are supplied through the high-tension switchboard shown at the extreme left, with switches on corrugated bases and insulated by barriers, and Thomson inclined-coil instruments to measure the current flowing, which is adjusted for a slight leading wattless component. The motors shunt somewhat in time with the engine strokes, but not enough to cause trouble, the ammeters, which are not deadbeat, swinging through about a quarter of their full scale deflection.

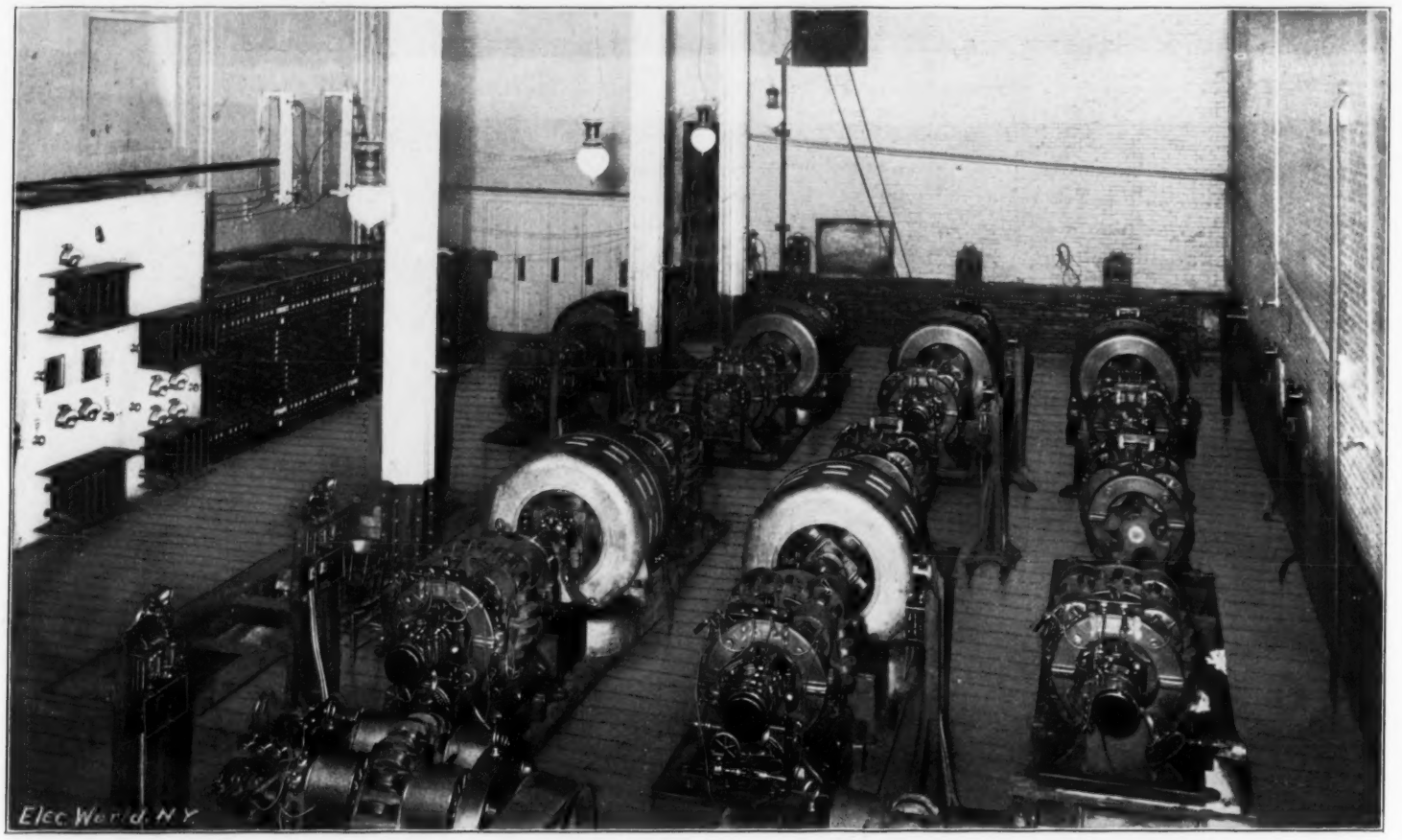


Fig. 7.—Synchronous Motors Driving Arc Machines in Sub-station A.

This sub-station does not contain any rotaries or other machines for transforming the high-tension current into direct current for the three-wire distributing system, but does contain a 14,000-ampere-hour storage battery attached to the latter. This storage battery is used to steady the load and to regulate the voltage on this part of the system by means of four end-cell switches, two of which are shown in Fig. 8. As is clearly indicated, there are four switches in groups of two, one above the other, two attached to the positive terminal and two to the negative terminal of the battery, the neutral being connected in direct without any switching arrangements. Each switch consists of a large number of copper leaves or strips, with one end bearing on the bus bar in the foreground and the other on any one of a row of contacts connected to the cell terminals. There are two groups of these strips in each switch, one forced downwardly against the contacts and bus from above and the other upwardly from below, and both attached to a nut travel-

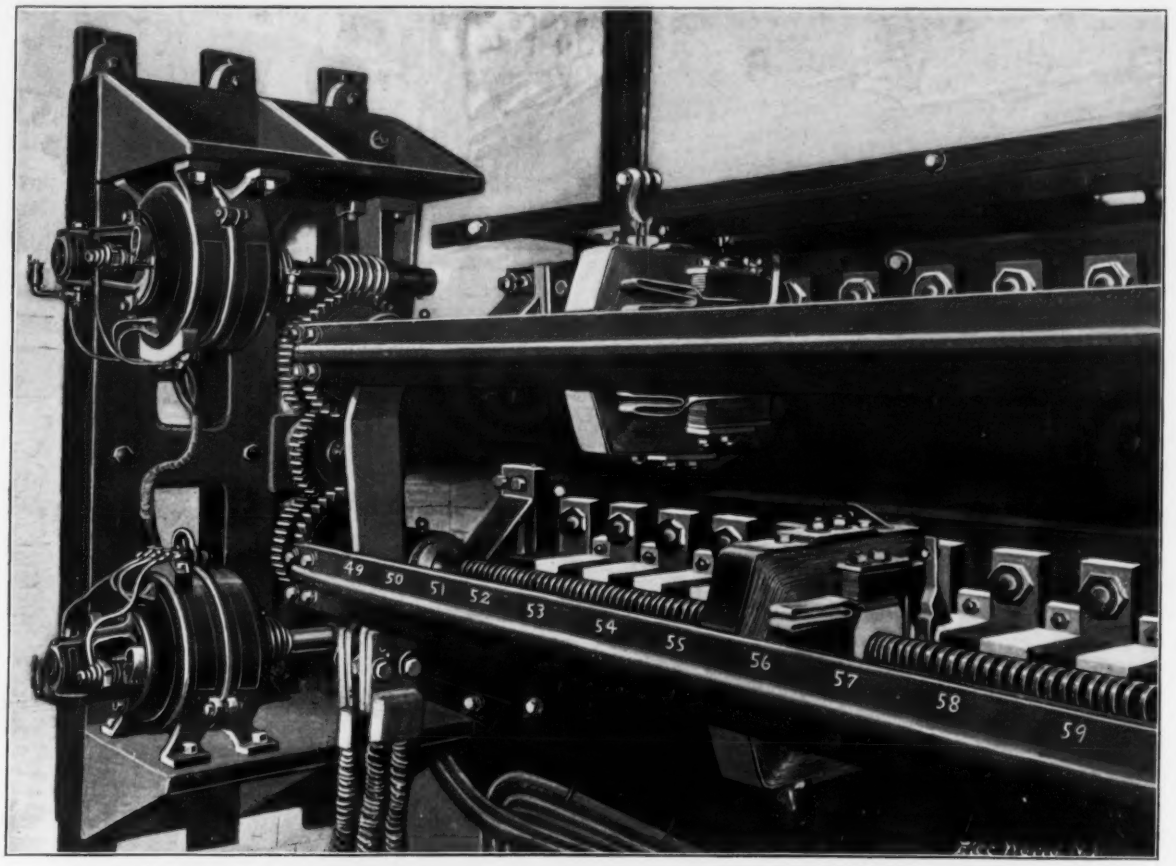


FIG. 8.—TWO OF THE END-CELL SWITCHES.

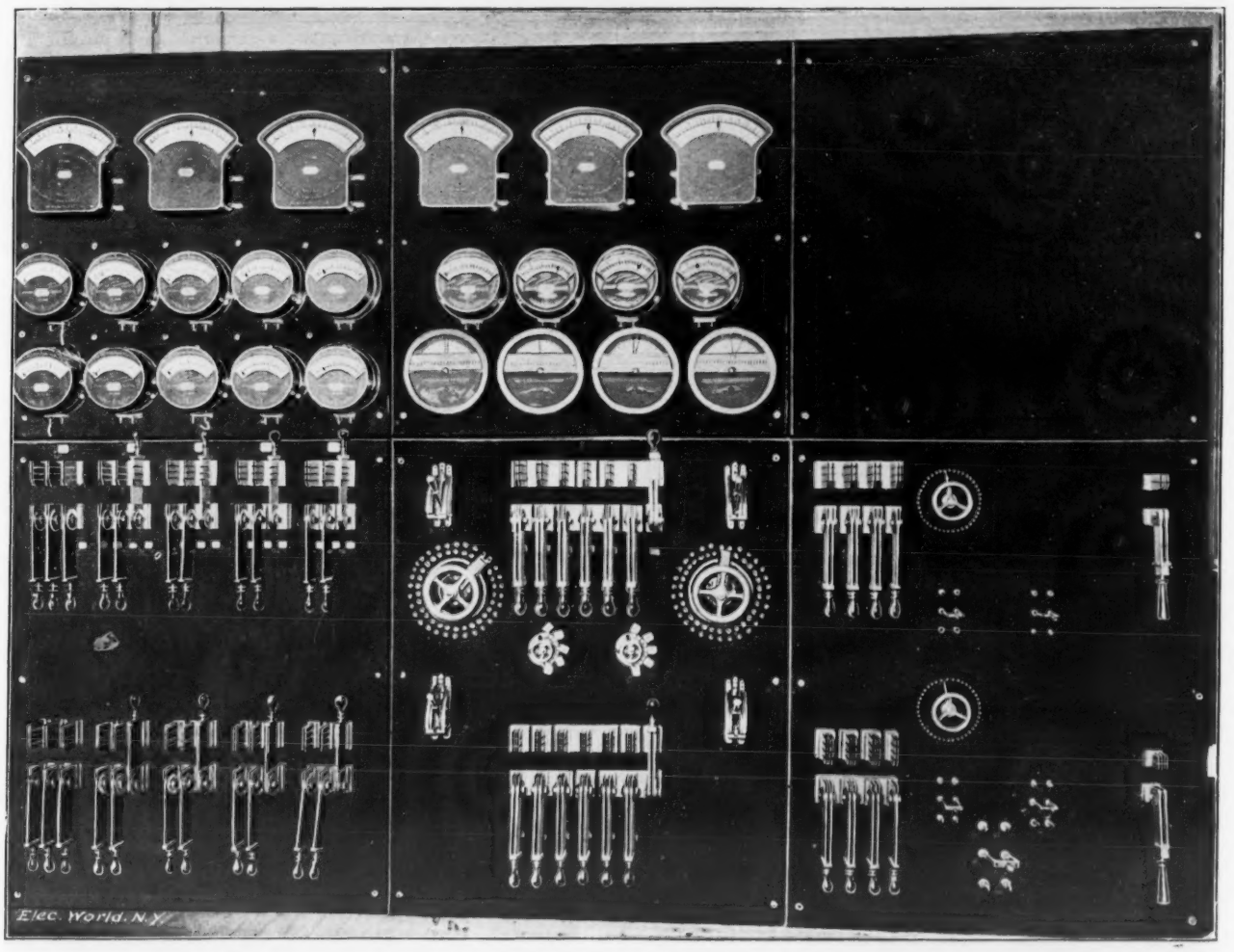


FIG. 9.—A VIEW OF THE BATTERY SWITCHBOARD AT SUB-STATION A, BROOKLYN EDISON COMPANY'S PLANT.

ing on the long screw shown. The screw is geared to a small Lundell motor, the rotation of which is controlled from the main board. To prevent the circuit from being opened in passing from one contact to another, and without short-circuiting the cell connected between these two contacts, there is attached to the main brushes of copper strips a small auxiliary brush, which is connected with the main brush through a German silver strip. This maintains the continuity of the main circuit through the battery without forming a shunt of too low resistance about the single cell.

The handsome switchboard shown in Fig. 9 allows the measurement and control of the battery and consequently of the load and voltage of this part of the system. The end-cell switches are mechanically connected with instruments on this board, showing their position, and with small hand switches by which they may be advanced step by step from contact to contact.

THE FIRST DISTRICT STATION.

One of the most interesting sub-stations is that on Pearl Street and known as the First District Station. It was originally erected in 1889 and fitted with high-speed engines belted to Edison bipolars on the floor above, this equipment being later replaced by multiple-expansion engines direct-coupled to multipolar smooth-body disc-commutator machines, from which the load has now been taken except between the hours of 5 and 12 P. M. by a row of four rotary converters installed beside them and shown in Fig. 1. These are each of 200-kw capacity, taking the 25-cycle current at about 88 volts, three-phase, on three collector rings at one end and giving off direct current at about 115 volts when running at 375 r. p. m. The machines are notable for the heavy commutator as compared with the small amount of iron in the magnetic circuit, the actual length of the commutator being considerably greater than the active length of the armature windings. This feature, while it looks odd to eyes accustomed to generators, is, of course, the proper thing in rotary converters, owing to their absence of field distortion and their low coil-heating compared with that of generating machines giving the same output. In two rows, each comprising a three-phase group, are six single-phase General Electric air-blast transformers, the two groups respectively taking the 6000-volt line current from two independent incoming three-conductor feeders and delivering low-tension alternating current from each group to a three-phase induction-regulating transformer (see Fig. 10), consisting of a group of three boosting transformers with primaries mounted on a rotatable core, which can be turned so as to either add to the pressure or subtract from the pressure of the secondary windings by any amount up to a maximum of 7½ per cent., giving a 15 per cent. range of adjustment. The rotating part is driven by a miniature induction motor through a double-reduction worm gear, the control of the motion of this little induction motor being effected by a small triple-pole throw-over switch on the main switchboard. The double reduction gear, of course, gives a good locking device and prevents the torque of the regulator from moving its rotatable part. The switch seen on the front of the regulator is designed to cut out the motor at the limit of proper motion.

The direct-current switchboard of this station is arranged for three sets of positive and negative buses for high, low and medium pressure, with switches to tie them together at times of light load and arrangements to connect any dynamo or rotary to any desired one of the three buses. The panel for the four rotaries is shown in Fig. 11. Each has one alternating and one direct current ammeter and three switches, one to throw it in series with a fixed starting resistance and the others connecting to two of the buses respectively. One pole of the direct-current end is of course permanently connected to the neutral. This panel contains no alternating-current apparatus other than the small switches by which the miniature induction motors controlling the regulators described above are operated, thereby varying the impressed alternating e. m. f. on the rotaries and—in case the engines are running—varying the distribution of the load or even reversing the direction of transformation of the converters, and when the engines are not running varying the e. m. f. delivered. The high-tension alternating-current lines run through a board on the floor below, and in the low-tension leads there is only a triple-pole switch on a pedestal of the rotaries at the collector-ring end.

Fig. 10.—One of the Induction Regulators.

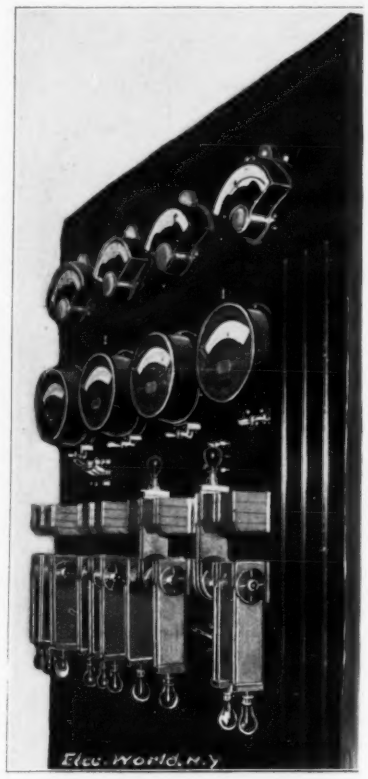


Fig. 11.—Four Rotary Panels.

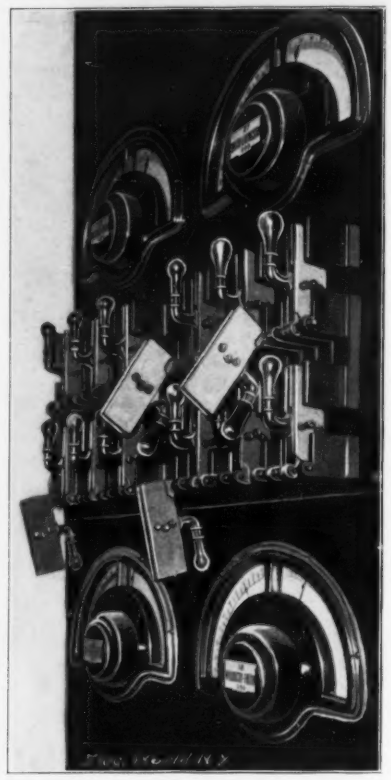


Fig. 12.—The Switches and Meters for Four Feeders.

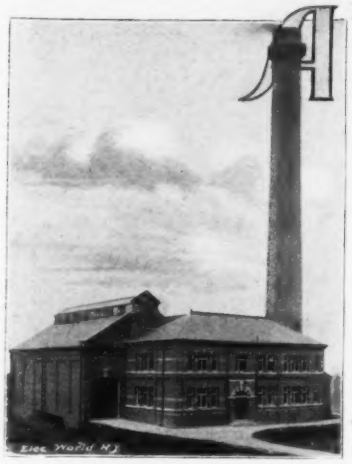
A large number of low-tension feeders branch from this board with the usual instruments and switches. An interesting type of measuring instrument is the duplex ammeter, shown in Fig. 12, the needles of the positive and negative meters each swinging through a quadrant, the two quadrants forming a semi-circular face. The feeder switches are removable, and may be hooked into one or another position, giving different voltages.

Credit for the information given above, as well as for much of the original work involved in the apparatus described, is due Mr. W. S. Barstow, general manager of the Kings County Electric Light & Power Co., and Mr. F. G. Sykes, superintendent of stations.

Dynamo Driving by Man Power.

According to "Indian Engineering," it has been proposed to run dynamos for electric light purposes on the Indian frontier by treadmills operated by convicts.

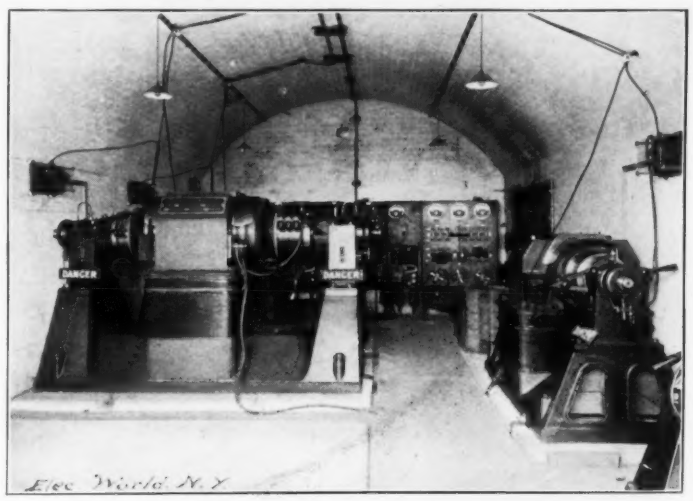
The Municipal Electric Lighting Systems of Hull and of Folkestone, England.



A NUMBER of interesting British plants with the typical features of modern English design, bipolar dynamos, central-valve engines, a high-voltage three-wire distributing system, storage-battery sub-stations, etc., have been described in recent issues of the London "Electrician," from which the following facts and illustrations concerning two of them have been taken. The feature about both of these differentiating them most widely from American practice is the combination of a three-wire distribution with 450 volts between outers and a high-tension direct-current generating and transmitting system.

THE HULL MUNICIPAL PLANT.

The power is generated at 2250 volts direct current by bipolar dynamos, and at this pressure is fed to single-armature direct-current transformers in sub-stations, where it is reduced to the voltage of the three-wire system. At the present date there are 863 consumers connected to the mains, and lamp connections aggregate 67,900, while no less than 16½ miles of mains have been laid, including the 3¼ miles now actually being laid. The customers include a great variety of consumers, there being, in addition to the ordinary lighting consumers, a fairly large motor load for printing and other work. We will now proceed briefly to describe the equipment of the new station and the sub-stations which have been recently erected.



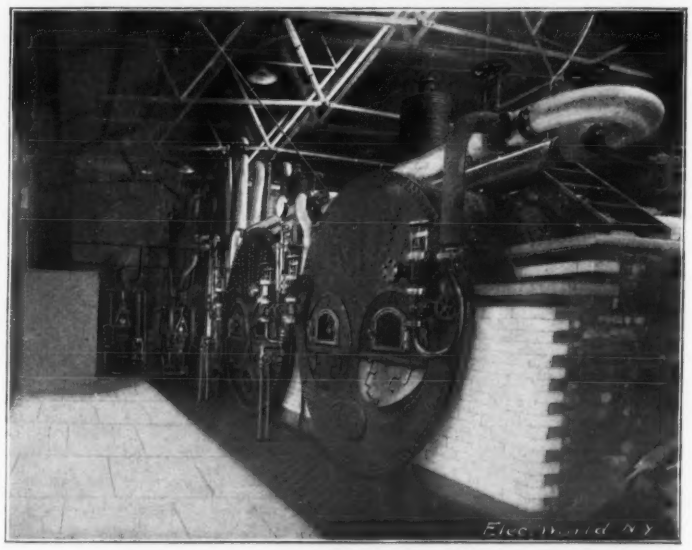
ARGYLE STREET SUB-STATION MACHINERY ARCH.

In the boiler room there are at present erected two Lancashire boilers, each 30 feet in length and 8 feet in diameter, together with a Babcock & Wilcox boiler of 150 horse-power. The boilers work at 150 pounds pressure, and are at present hand-fired. In conjunction with the boiler plant there is a Green economizer, with motor-driven scrapers. The feed pumps are of the direct-acting vertical type, with the pump underneath. They throw their supply from a tank filled with softened water, a water softener of the Pemberton type being used, together with a clarifying or filtering tank and apparatus for thoroughly mixing the reagent solution with the water to be softened. The feed supply is arranged on the duplicate ring-main system, similar to that employed for the steam supply, and arranged so that any pump can supply any boiler either with cold or hot water. In addition to the feed pumps there is an independent set of injectors. The water for the feed, as well as the condensing plant, is pumped out of an adjacent drain by means of two motor-driven centrifugal pumps, and is discharged into a large overhead tank of 29,120 gallons capacity. From this tank the water is supplied to the two ejector condensers through a 12-inch pipe. The exhaust from the engines can be turned either into the condensers or into an atmosphere pipe of 15-inch diameter which runs along under the floor and is carried upward outside the building. The steam ring consists of two parallel lines of 8-inch wrought-iron solid-drawn pipe, with welded flanges resting on cast-iron chairs behind and above the boilers and connected at the ends with copper U-bends of the same size as the pipe. Into this ring each boiler feeds by a separate copper pipe bent into an S shape so as to avoid strains due to expansion. The standpipes are each provided with a complete set of valves, enabling each boiler to be used independently, an arrangement which is also applied to the engines running off the ring mains. The plane of the ring is inclined downward toward the boilers, and it is drained at two points by steam traps.

In the machine room there is erected a high and low pressure continuous-current plant, having an aggregate capacity at present of 456 kilowatts. The low-pressure plant consists of two Willans engines, each indicating 100 horse-power under 140 pounds steam pressure. These engines run at 450 r. p. m., and are coupled direct to bipolar dynamos, each giving 130 amperes at 300 volts. These machines are for the supply of nearby consumers, also for the pump and economizer motors in the plant. A motor generator is also installed in the building, and is used for balancing purposes or for supplying light loads in conjunction with the battery. The high-pressure plant consists of two Willans engines, each capable of developing 360 horse-power at the same pressure when running at 350 r. p. m. These are coupled to bipolar dynamos, each giving 90 amperes at 2250 volts. These generators are separately excited from the 225-volt circuit. The armatures of these machines are wound on the Eickemeyer principle. All the engines are fitted with Messrs. Willans and Robinson's automatic expansion gear, and a separate condenser is provided for each engine, the condensers being of the Körting ejector pattern, and arrangements are made so that each set can be run either condensing or non-condensing, as required. A 10-ton hand-power traveling crane spans the engine room.

The switchboard equipment consists of two separate boards for the high and low-pressure plant, respectively. These have been made as nearly as possible fireproof, being composed of 1½-inch slate slabs mounted on iron frameworks. The low-tension board contains two dynamo panels, one battery panel, two feeder panels, one Board of Trade panel, one motor-generator panel, and one works distribution panel. Each dynamo panel is fitted with a Weston ammeter and voltmeter, a d. p. switch with over and under load release, a throw-over main switch and field regulating switches. The battery is placed on one side of the three-wire system, and eighteen regulating or end cells are connected to the switchboard. All motors, lights, etc., in the works are connected to throw-over switches on the works distribution panel, so as to enable them to be run from either side of the system. Thomson-Houston wattmeters are installed in the low-tension feeders both here and at the sub-stations, so that all current delivered to the distributing mains is metered.

The high-tension switchboard contains two dynamo panels, one Board of Trade panel and six feeder panels, and four spare panels for extensions are provided. Each dynamo panel contains a Wes-



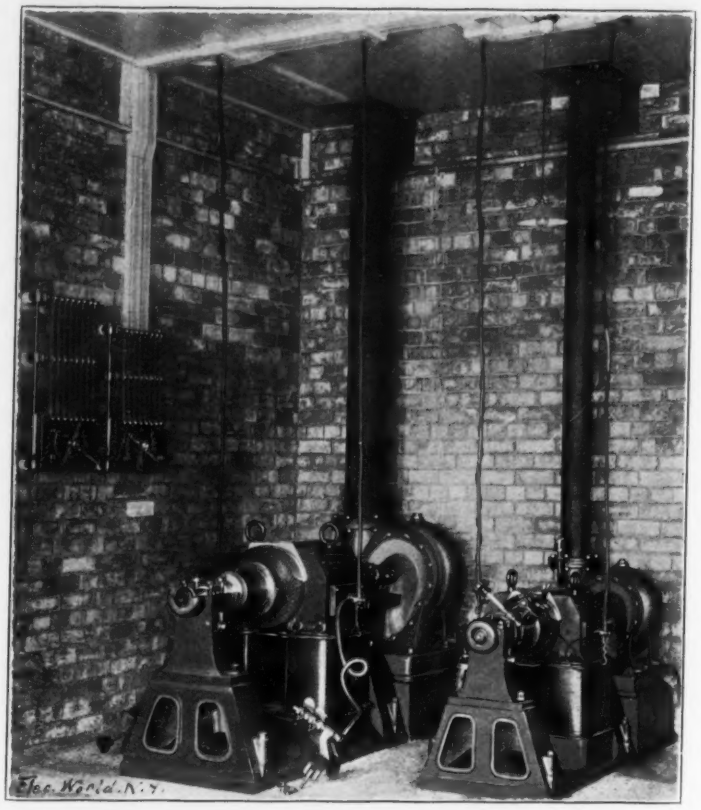
A VIEW OF THE BOILER ROOM OF THE HULL CENTRAL STATION.

ton ammeter, a Kelvin voltmeter, a d. p. switch with over and under load release and field regulating switches. The dynamos are connected by the d. p. switches to the high-tension bus bars, from which the feeders are tapped. The feeder panels each contain a Weston ammeter and voltmeter, a d. p. switch with maximum cut-out, and transformer, starting and regulating switches. The voltmeters on the feeder panels are connected to the feeding points on the low-tension mains, and the pilot wires are connected to them via the operating coil of a long-range switch on each transformer. By short-circuiting the voltmeter about five amperes is made to pass through this coil, and the long-range switch is actuated, connecting a transformer to that particular feeding point. A repetition of the process throws the switch into the "off" position.

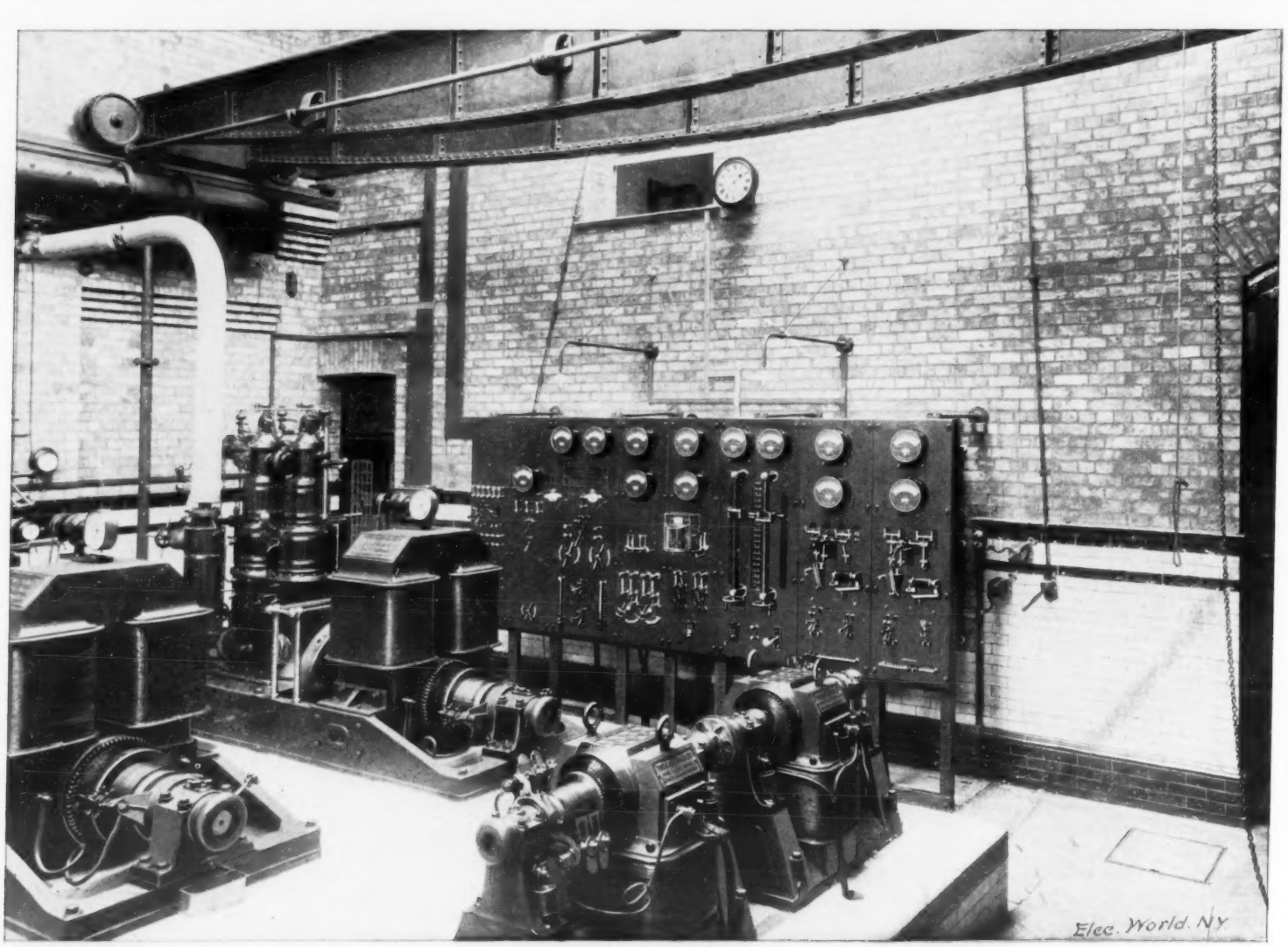
The battery room contains 126 Pritchett and Gold 11-plate cells in glass boxes. The capacity of this battery is 300 ampere hours at 225 volts.

There are at present two sub-stations, one at Albion Street and one at Argyle Street. The building at Albion Street was specially designed for the purpose, and contains two 90-kw direct-current transformers and a motor generator. Room for an extension of the plant is provided.

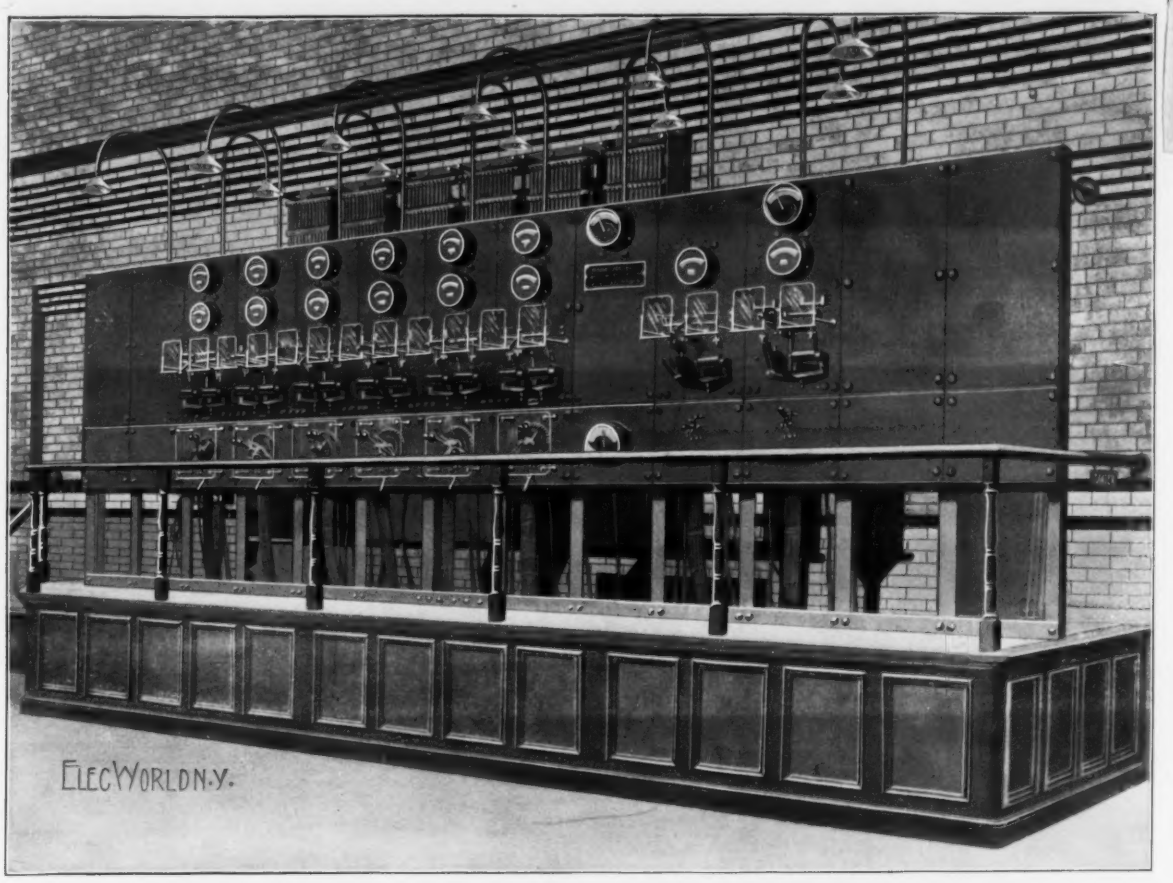
At Argyle Street four railway arches have been utilized, two of which are used as stores for the outdoor department, one as a battery room and one as a transformer chamber. (See page 585.) In the battery arch there are 240 Pritchett and Gold cells similar to those at the generating works. These are charged in three sets of 80 cells each off the distributing mains, and are discharged in two sets of 120 cells. The switchboard is situated in the transformer arch, where there are two 90-kw and two 45-kw machines, with the necessary switches, etc. The 90-kw transformers are wound for a step-down from 2250 to 450 volts, and the two smaller transformers are wound from 2250 to 225 volts. The 90-kw transformers at Albion Street supply a portion of the old network, and are wound for 2250



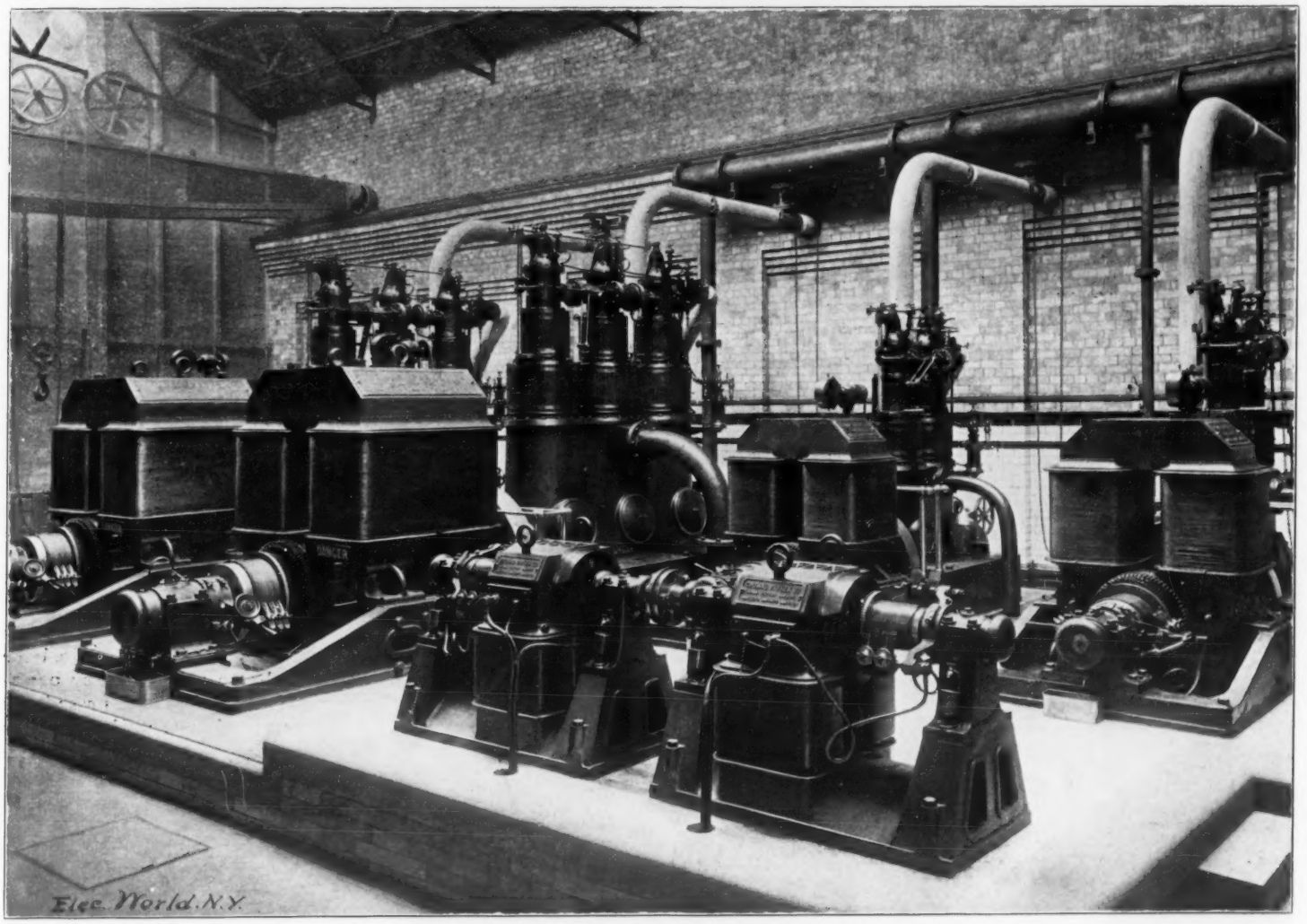
Motor-Driven Centrifugal Pumps at Sculcoates Lane Station.



Engine-room Interior, Showing Low-Pressure Generators, Motor-Generator and Low-Pressure Switchboard, Hull Central Station.



VIEW OF THE HIGH-TENSION SWITCHBOARD OF THE HULL CENTRAL STATION.



AN INTERIOR VIEW SHOWING ENGINES AND DIRECT-COUPLED GENERATORS OF THE HULL MUNICIPAL CENTRAL STATION.

to 225 volts, the motor generator forming a connecting link between the old 220-volt three-wire and the new 440-volt three-wire networks. The transformer armatures are of Messrs. Parker's usual type, with high and low-tension winding on the same core and with a commutator at each end. They are "Eickemeyer" wound, with an earthed metallic shield between high and low tension windings. The lubrication is by a force pump on each bearing, and the machines can be run for long periods without attention.

MAINS.

The mains extensions have been carried out by Messrs. Siemens Brothers & Co., and consist of six high-tension circuits running from the generating station in Sculcoates Lane to the two sub-stations, and low-tension feeders running from the generating station and these sub-stations to various points in an extensive network of distributing mains. The high-tension feeders, pilot and telephone wires are drawn into Doulton stoneware conduits. These conduits are made in 3-foot lengths, and are jointed by means of stoneware cradles with Portland cement. Manholes built of brickwork on concrete foundations are provided at all corners and bends and where otherwise necessary, and are provided with cast-iron frames and covers, and ventilated by means of stoneware pipes connected to a small ventilator frame. The high-tension feeders (of which about 17,000 yards have been laid) are 0.06 square inch and 0.03 square inch sectional area, concentric, insulated with impregnated fibrous material, lead-covered and externally taped and compounded. The low-tension feeders consist of about 4600 yards of 0.5 square inch concentric lead-covered cable, armored with two layers of 0.05 inch hoop-iron, and laid direct in the ground. Three 9 and 12 conductor pilot cables are laid alongside the feeders, and a 4-conductor "dry core" (air-space) telephone cable permits of communication between the generating and sub-stations.

About 24,000 yards of mains have been laid of the triple-core, impregnated-fibre insulated, lead-covered and armored type, the positive and negative conductors being 0.15 square inch in section. The advantages of this class of distributing main for three-wire systems are now universally recognized. It combines flexibility with facility of jointing, the service and other boxes employed being of a much simpler construction than those for triple concentric mains.

The straight joints are made in cast-iron boxes in two halves bolted together. The internal fittings consist of copper sleeves and sockets for sweating the conductors into, and are embedded in the hard-setting insulating compound with which the boxes are filled. About sixty disconnecting boxes, both three-way and four-way patterns, have been inserted in the network, and allow of any section of the mains being rapidly cut out or disconnected for testing purposes.

The internal fittings of these boxes are so arranged that either disconnecting copper links or fuses can be used. They are set in brick pits, with manhole frames and covers of similar construction to the draw boxes.

The service cables are of the twin pattern, india rubber insulated, lead covered and armored, and are connected to the mains through cast-iron T boxes. All the cables, before and after laying, were subjected to exhaustive tests with satisfactory results.

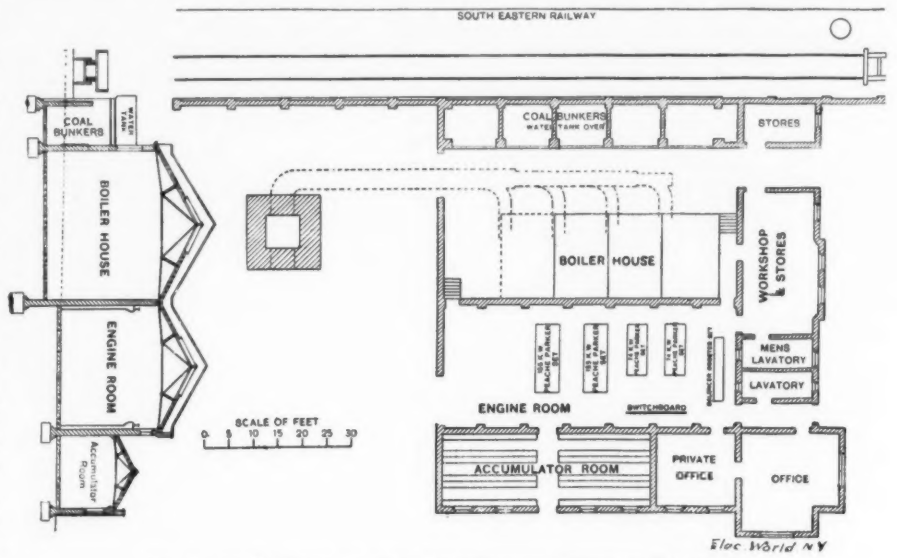
View of the Accumulator Room, Folkestone Central Station.

THE FOLKESTONE WORKS.

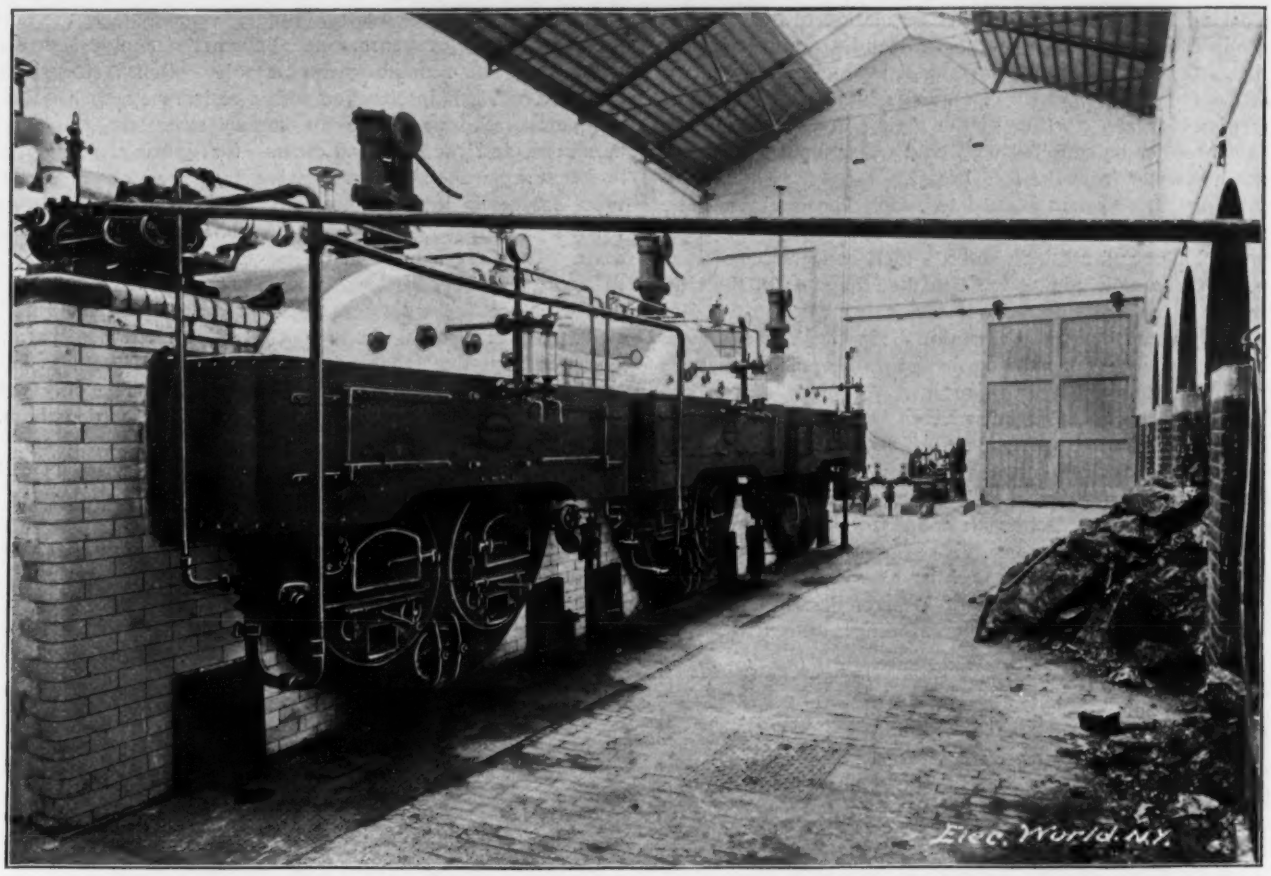
The buildings are entirely of fireproof material, the roof being constructed of steel, slate and glass. The slates are fastened to the angle iron purlins by lead clips, and expanded steel lathing, plastered, is attached to the inside of the engine-room roof. The cast-iron water tank over the coal bunkers has a capacity of 17,500 gallons. The chimney is 150 feet high, and its area at the narrowest part is 49 square feet; it is lined with firebrick to about 50 feet. It is interesting to note that the chimney was built from the inside, an electric motor being employed to drive the winch (through ordinary belting and friction gear) used for lifting the workmen and the materials.

Exterior of Folkestone Plant.

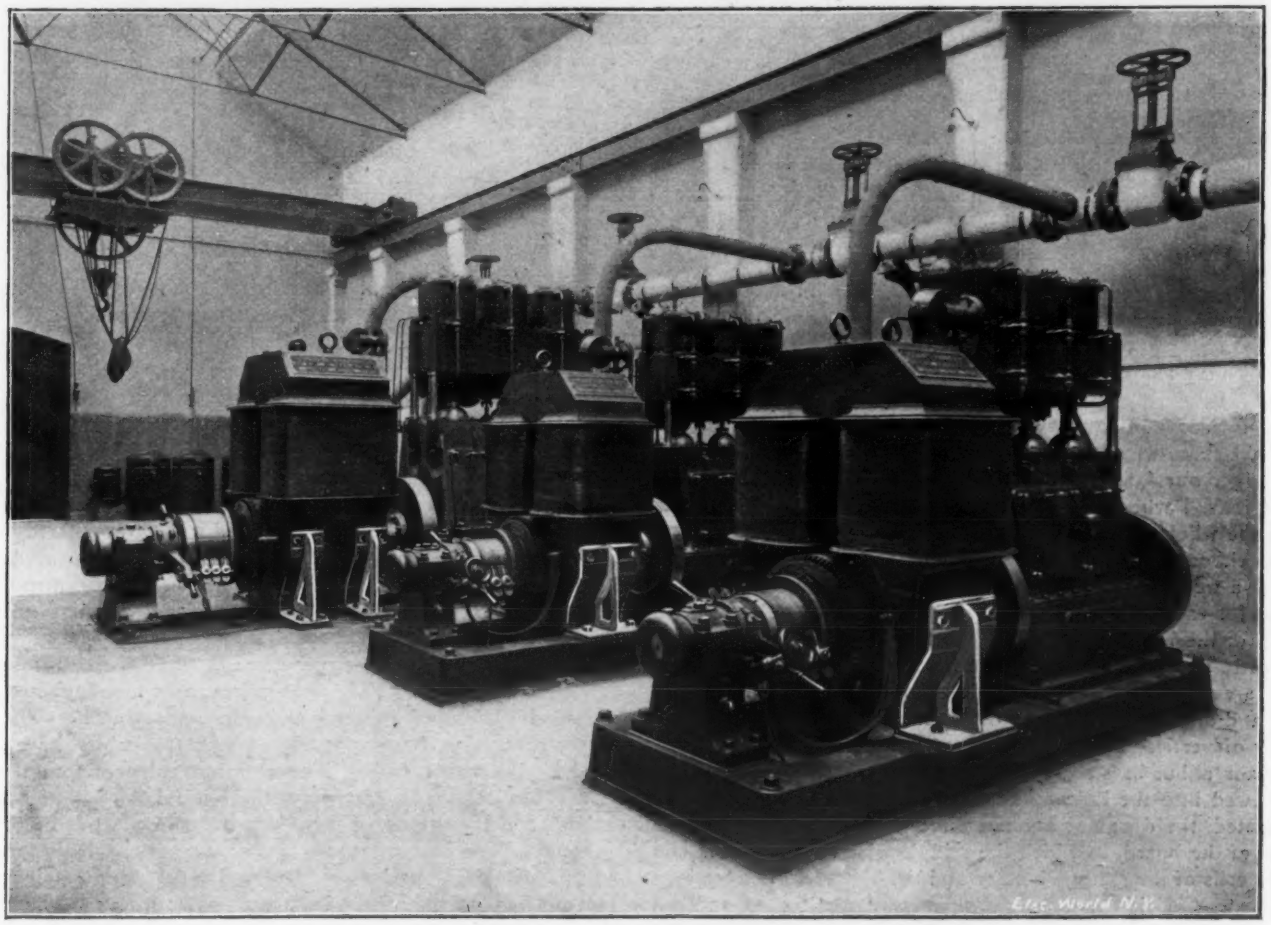
The boiler-house is at present equipped with three marine-type boilers 14 feet long by 8 feet diameter, with space for two more if required. As the water is very hard, an exhaust "heater detartoriser" of Mr. William Boby's make is employed. This is capable of dealing with 12,000 pounds of water per hour. The water enters at the top and flows downward till it reaches the suction pipe of the feed pumps, which it enters at a boiling temperature. The apparatus consists of a number of circular trays set one upon another so as to form a column. Each tray is always nearly full of water, and the exhaust steam from the engines, entering near the bottom of the apparatus, bubbles through the water, raising it to boiling temperature, while the amount of back pressure caused in the exhaust pipe is said to amount only to a few inches on the water gauge. The heating of the water causes the carbonates of lime to be deposited, and the sulphates are dealt with by means of a small amount of common soda solution, which is automatically injected at the top of the detartoriser, in exact proportion to the amount of water passing through the machine. No attempt is made to remove the sediment by blowing out, but when cleaning is required the trays are lifted down and cleaned—a by no means lengthy operation, as the deposit, though compact, is soft. As there is practically no pressure in any part of the apparatus when at work, the joints are made by the weight of the parts without bolting by simply employing ordinary glazier's putty. The apparatus is stated to reduce the hardness of the water to not exceeding three grains per gallon, and it possesses the advantage that its efficiency as a heater does not diminish as load is added to the plant. The water is fed by two three-throw pumps with gun-metal plungers, driven by bipolar shunt motors. The pumps will deliver 12,000 pounds of water per hour when running at 43 r. p. m., this low speed being attained by the use of double-reduction gear with raw-hide teeth to the pinions.



Plan and Section of the Folkestone Central Station.



VIEW OF THE BOILER ROOM OF THE FOLKESTONE CENTRAL STATION.



INTERIOR OF THE ENGINE ROOM OF THE FOLKESTONE CENTRAL STATION, SHOWING DIRECT-COUPLED GENERATORS.

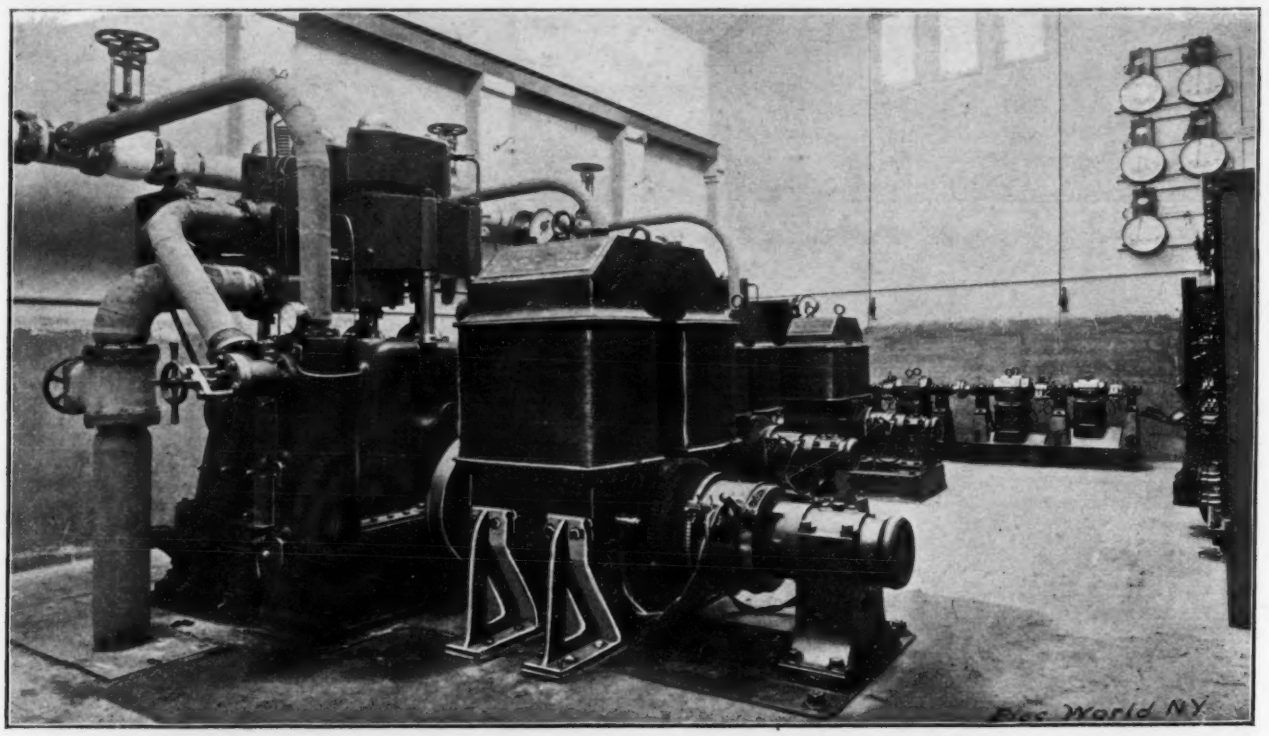
Switching apparatus is provided to allow a supply of 210 or 420 volts, thus giving two speeds, and further regulation of the speed is obtained by inserting resistance in the field and armature circuits of the motors. The feed piping is arranged in duplicate with two connections to each boiler, with the requisite number of valves to isolate any pump or any portion of the piping in case of failure. The pumps can either be supplied with cold water from the supply tank or with hot water from the feed heater.

The usual ring main system is used to supply the engines. The mains are of 7-inch steel with copper bends, with 5-inch steel connections to the boiler and 2½-inch and 3½-inch copper connections to the engines. The main piping is drained at the ends of the ring to Geipel steam traps, and connections for drains are also fitted at the foot of the separators on the engine beds to similar drains. Steam being continually connected to these separators, dry steam is always available for starting up any engine.

A good view of the engine room is given in one of the illustrations. Three generating sets are installed at present, one of 246 horse-power and the other two 120 horse-power, when running at 375 and 480 r. p. m. respectively, with steam at 140 pounds at the stop valve. All are of the Peache type coupled to Parker dynamos. They are single-acting, three-crank, six-cylinder engines, and run very silently. There appears to be nothing exceptional in the construction of the dynamos. They are of Messrs. Parker's two-pole type, with steel magnets and Eickemeyer windings, designed to give from 420 to 460 volts' pressure, and to be connected across the outers of the three-wire system; the smaller ones give 160 amperes, and the larger ones 380 amperes. The booster and balancer set is also of Messrs. Parker's make. There is an 8-ton overhead crane traveling the whole length of the engine room.

The switchboard is made of enamelled slate supported on a steel frame with a wooden moulding round the edge. As usual the three panels are for each of the three wires. The feeders are brought in at the top of the board through double-pole fuses to the ammeters and thence to alternate vertical bars on the back of the board. The dynamos are connected, on one side through Siemens minimum cut-outs, and on the other side through ammeters, to the remaining four pairs of vertical bars, and the connections are made through three horizontal bus bars at the back of the board by means of brass plugs screwed into the holes running through from the front. As already stated, the dynamos are not directly connected to the central panel of the board, to which the middle wire of the feeders and the centre cells of the storage battery and the "booster" connections are brought. On this panel is a 14-way regulating or end-cell switch for each side of the battery, and a throw-over switch, by means of which the cells are connected either directly to the bus bars or to the armature of the booster. Two other throw-over switches are provided for the purpose of exciting the field of the boosters and short-circuiting them immediately the circuit is broken, thereby preventing an abnormal rise of pressure in their windings. The remaining double-pole switch is for starting the balancer, and it is interlocked with a resistance switch. On the upper part of this panel are the battery ammeters, the middle-wire ammeters and the zero indicators, for putting the dynamos or boosters in parallel. These zero indicators, which are of the Kelvin type, are really low-reading voltmeters, but they are designed to withstand high pressures, and have their zeros in the middle of the scale. They are connected to the poles of the switch it is desired to close, and when the indication is zero it is known that the two machines are at the same pressure, and the attendant can close the switch. This forms a simple and effective method of paralleling.

It will be noticed that, with the exception of the zero indicators, there are no voltmeters on the switchboard. The only voltmeters employed are those on the left-hand wall of the engine room. They are electro-static voltmeters of the standard Kelvin engine-room type, and are connected at the ends of the pilot wires from the feeding points. The large, open scales are visible from every part of the engine room. Thomson-Houston meters are fitted on each dynamo circuit, and Aron meters, with Miller's single-dial attachment, are used for the accumulators. These latter are 230 cells in glass boxes erected on wooden stands in two tiers. They are guaranteed to give a discharge of 80 amperes for 9 hours or 119 amperes for 4.



Engine Room Folkestone Central Station, Showing Switchboard at the Right and Boosters in the Background.

The supply is at 210 volts at the consumers' lamps, and the arc lamps are connected in series of eight across the 420-volt mains. Owing to the distance of the station from the centre of the supply area, the feeders and distribution mains are a very important feature of the system. The cables are insulated with impregnated jute, lead-covered and armored, and laid directly in the ground. Tarred boards are laid over them for protection from workmen who may be making excavations in the neighborhood at some future time. The feeders are triple concentric, with heavy lead-covering and steel-tape armoring, being connected to the distributing network at large feeder boxes. The pilot wires are three-conductor lead-sheathed steel-taped cables laid in the same trench as the feeders. Three core, in preference to triple concentric cables, have also been used for the mains, owing to greater convenience in connecting the house services. The section of the neutral wire of the feeders is half that of the others. Sixty-eight arc lamps are being erected at present. They take a current of 10 amperes and burn for fourteen hours with single carbons. On each post are two incandescent lamps of 25 candle power for use after 11:30 P. M. The circuits of the arc and incandescent lamps are connected to main circuits tapped from the network boxes by means of four-core non-hydroscopic cable, which is lead-sheathed and steel-armored, two of these

wires being for the arc lamps and two for the incandescent. The designs of the posts selected by the corporation have very small chambers in their bases, so that there is only room for the isolating switches and substitutional resistances in them. The circuit switches and resistances are contained in pillar-boxes similar in appearance to those frequently used for the line switches of a tramway system. There are five of these switch pillars, each arranged for three circuits.

The Work of the American Institute Committee on Co-operative Research.

The committee appointed by the American Institute of Electrical Engineers to suggest problems for research on the part of scientific schools and to co-ordinate the results obtained has suggested the list of subjects given below, which will certainly be valuable to the heads of the electrical departments in the various technical schools, with results which should be of great importance in the advancement of the science:

(1) The effect of sustained high temperature upon the insulation resistance of dielectrics.

(2) The influence of sustained high temperature upon the dielectric strength of insulating materials.

(3) The influence of sustained high temperature upon the hysteretic coefficient of commercial iron.

(4) The influence of chemical impurities in iron or steel upon the hysteretic coefficient.

(5) The hysteretic coefficient of magnetic alloys.

(6) The temperature coefficient of resistivity in commercial copper wires.

(7) The temperature coefficient of resistivity in commercial aluminum wire.

(8) The temperature coefficient of resistivity in alloys commercially employed. (It is desirable to include analysis of the alloys tested as well as their physical properties.)

(9) The highest conductivity obtainable in copper wire at any standard temperature.

(10) The highest conductivity obtainable in aluminum wires at any standard temperature.

(11) The analysis of dielectric losses between parallel copper wires maintained at high e. m. f.; (1) alternating and (2) continuous, into component parts, such as chemical, electrical and mechanical.

(12) The influence of wave form of alternating e. m. f. upon the dielectric strength of dielectrics.

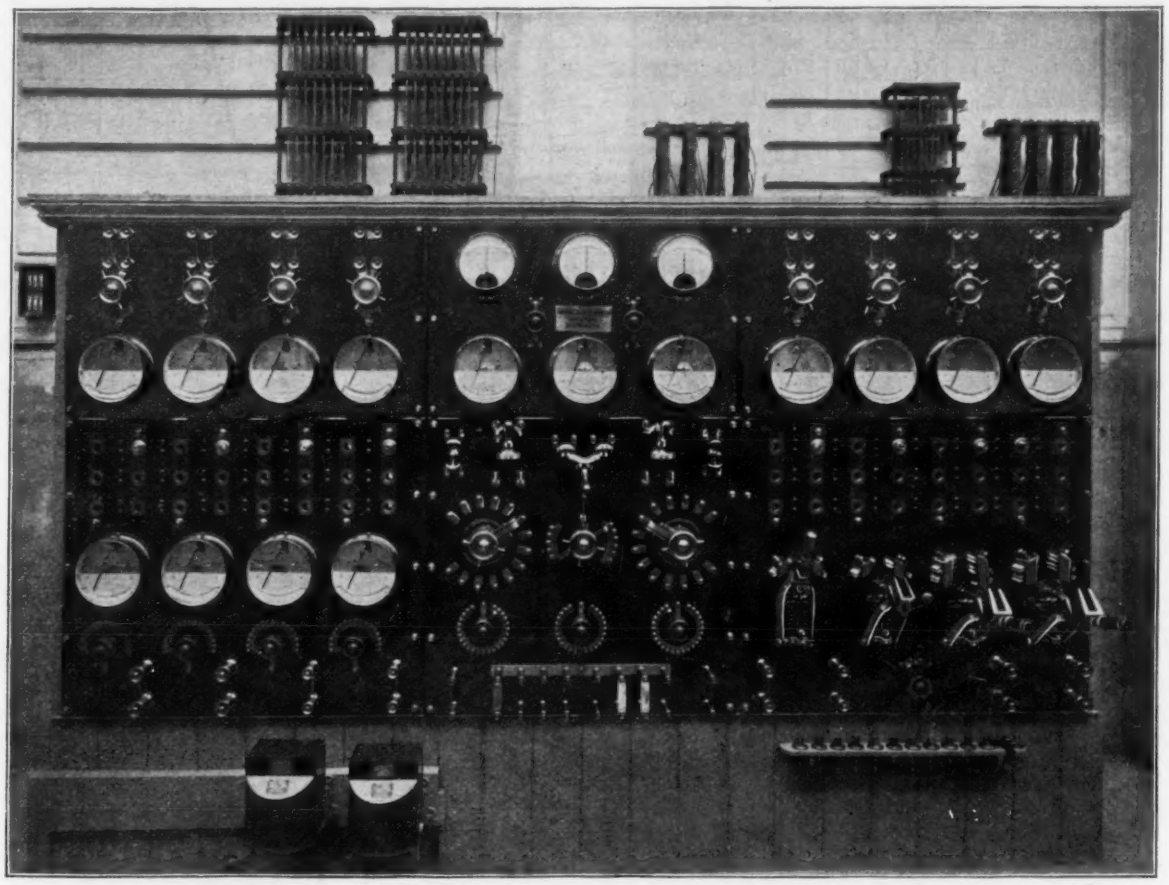
(13) The influence of wave form of alternating e. m. f. upon the sparking distance between needle-points in air.

(14) The influence of the room temperature upon the temperature elevation of dynamo machines under a given load, as computed from their increase in resistance under load. (Sec. 32, Preliminary Report of Standardizing Committee to American Institute of Electrical Engineers. June, 1898.)

(15) The distribution of temperature elevation in field coils of dynamo machines as dependent upon their form and dimensions.

(16) The relations between the "load loss" and "short-circuit core loss" of an alternator. (This has reference to Par. 16d, A. I. E. E. Preliminary Report on Standardization, June, 1898.)

(17) The counter e. m. f. of electrolytic deposition cells at potential differences ranging between the maximum polarization voltage and zero.



VIEW OF SWITCHBOARD AT THE FOLKESTONE CENTRAL STATION.

(18) The seat of the increased counter e. m. f. in storage cells during rapid discharge.

(19) The magnetic properties of alloys containing iron, nickel and cobalt.

(20) The magnetic restivity of powerfully twisted iron and steel wires, or of magnets composed of such twisted wires.

(21) The permeability of magnetic materials at low values of magnetizing force.

(22) The dielectric strength of different substances employed for insulating at different frequencies of alternation.

(23) The influence of very high frequencies of alternation upon the sparking distance between needle-points in air. (The highest attainable frequencies preferred.)

(24) The dielectric strength of vapors of different substances.

(25) Influence of wave-form upon efficiency of converters.

(26) The influence of magnetic field upon electrolytically deposited bismuth.

(27) The conditions giving rise to sparking at commutators.

High Voltage Power Transmission—II.*

BY CHAS. F. SCOTT.

The wave for no load and for both conditions of load is given in Fig. 10. The current taken by the two circuits in multiple is twice that to a single circuit. The variation from a straight line in one of the current curves is due to a change in wave form as the voltage is increased. The loss for the two circuits in multiple is about twice as great as for one circuit at low voltages, but it is less than that for one circuit at high voltages. Referring now to the wave form taken at high voltage, it is seen that the wave form for the two circuits in multiple has a lower maximum than that for one circuit alone. The reduced loss on the two circuits is undoubtedly due to the different wave at no load and is greatly distorted when supplying a leading current. In the no-load wave the value of the fundamental is 72.5 per cent.; the third harmonic 21.6 per cent.; the fifth harmonic 4.8 per cent. The corresponding loss is given in Curve 1, Fig. 9. The distorted wave makes the Thomson wattmeter read too high.

OTHER OBSERVATIONS AND TESTS.

"A series of observations were taken, extending over a period of thirty-three days, to determine whether there was any connection between the loss occurring on the lines and the variations in weather conditions. Three readings were taken each day. They were, in addition to the wattmeter readings, readings for barometric pressure, temperature, humidity, wind direction and wind velocity.

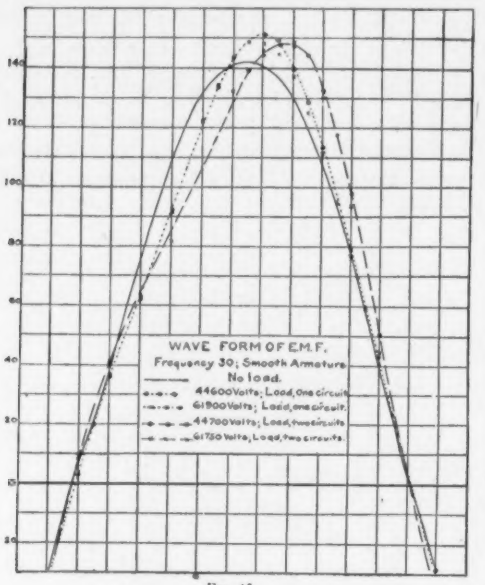

WAVE FORM OF E.M.F.
Frequency 30; Smooth Armature
No load.
44600 Volts; Load, One circuit
61900 Volts; Load, one circuit.
44700 Volts; Load, two circuits
61750 Volts, Load, two circuits.

FIG. 10.

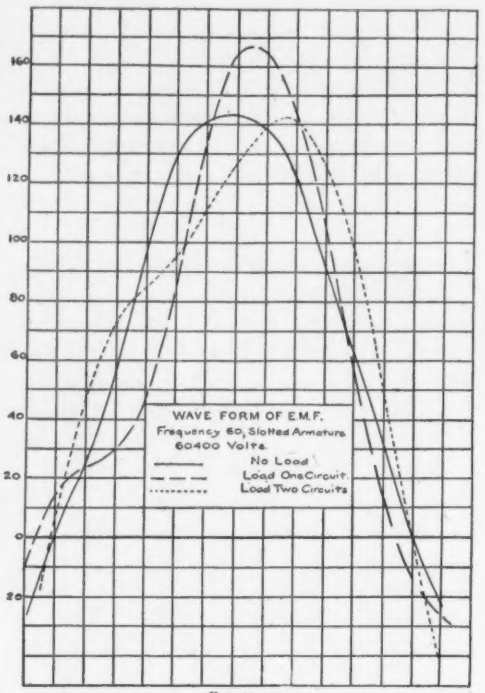


FIG. 11.

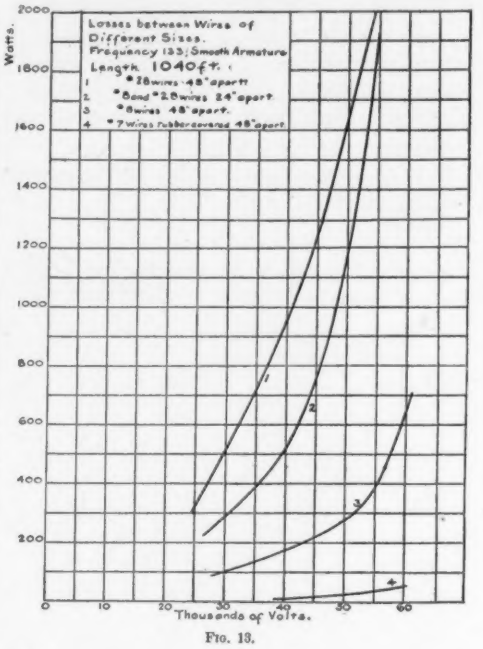

Losses between Wires of Different Sizes.
Frequency 133; Smooth Armature
Length 1040 ft.
1 *28 wires 48" apart
2 *8 and *28 wires 24" apart
3 *8 wires 48" apart.
4 *7 wires rubber covered 48" apart
Watts.
Thousands of Volts.

FIG. 13.

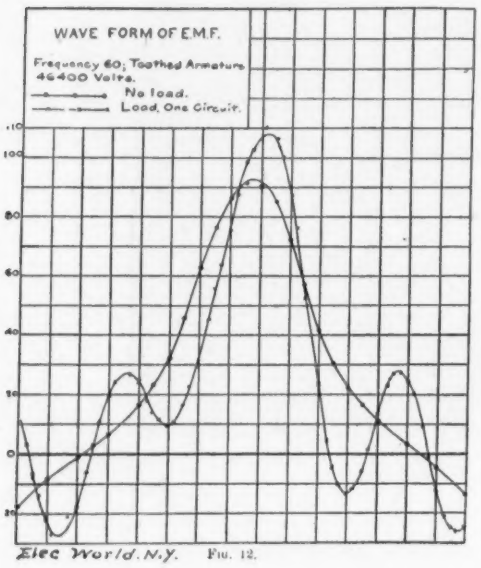


FIG. 12.

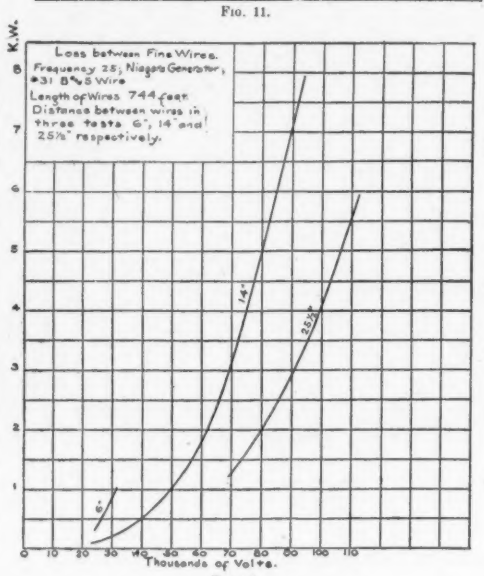

Loss between Fine Wires.
Frequency 25; Niagara Generator.
#31 B&S Wire
Length of Wires 744 feet
Distance between wires in three tests 6", 14" and 25½" respectively.
K.W.
Thousands of Volts.

FIG. 15.

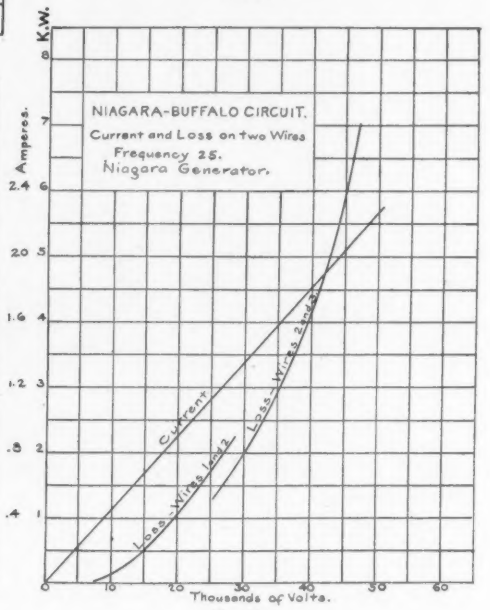


FIG. 14.

wave form when both circuits were connected. The distortion of the wave form is due to the reaction which the leading current produces in the generator and transforming apparatus.

Wave forms were also taken on the slotted armature giving 60 cycles. The wave forms are given in Fig. 11. The conditions are similar to those just described, in that a single circuit produces a wave having a much higher maximum than that produced when two circuits are run in multiple. The losses (which are not shown) bear the same general relation as that in the last case, namely, the loss with two circuits is greater at low voltage and at the high voltage is less than that on a single circuit.

A wave form was taken upon the toothed armature both at no load and also when supplying current to one of the circuits. These are shown on Fig. 12. This wave differs radically from a sine

*A paper presented before the American Institute of Electrical Engineers, Omaha, June, 1898. Continued from previous issue.

The weather observations were taken simultaneously at Ames and the King, using sets of weather instruments furnished by the United States Weather Bureau. The range of these observations is shown in a table given below, in which maximum and minimum refer to the maximum and minimum results obtained at any time during the thirty-three days over which the measurements extended:

Location.		Barometer.	Temperature. Deg. F.	Humidity. Per Cent.	Wind Velocity. Miles per Hour.
Ames.	Maximum.	22.19"	73.5	43.2	221
	Minimum.	21.68"	56.3	7.1	2
King.	Maximum.	21.82"	62.0	42.5	20
	Minimum.	19.81	47.8	3.0	3

"If there was any variation in the loss on the lines for this range of weather conditions, it was so small as to be inappreciable. The results of all measurements taken during this work seem to confirm the fact that the only weather condition whatsoever which affects the loss to any practical extent is that of precipitation. The loss seems to bear some relation to the size of the particles precipitated, being greater for a fall of snow in which the flakes are large than one in which the flakes are small.

"In the power transformers used the series reactance was comparatively small because of the subdivision of the coils. A change in the condition on the line as regards loss occurred when the Weston wattmeter was placed in circuit. This was detected by measurement upon the Thomson wattmeter, both when the Weston wattmeter was in circuit and when it was not. Moreover, the lines hiss when the voltage is 55,500 and the Weston wattmeter is out of circuit, but when the Weston wattmeter is thrown into circuit the hissing ceases, although the voltage rises to 57,700. The hissing sound is a characteristic of high-voltage lines and begins at the bend in the loss curves. It always accompanies luminosity of the lines.

"Along with this change there was another phenomenon not previously mentioned. This was a discharge which took place from time to time between the terminals of individual choke-coils. The discharge would occur sometimes between the terminals of one choke-coil and sometimes simultaneously on two or three of the choke-coils. These discharges made considerable noise, sounding very much like a pistol shot, and could be heard at a considerable distance from the transformer house. As the choke-coil terminals are distant from each other about 8¼ inches, it is not thought that this discharge took place through the air, but over the surface of the wood enclosing the choke-coil. The discharge, however, left no mark on this surface. Simultaneous with these choke-coil discharges one could hear, if standing under the line some little distance from the transformer house, a slight snap which seemed to be a phenomenon rather of the whole line than of any particular spot in it. Sometimes there was a corresponding snap over the lightning arresters. As the lightning arresters make more or less noise at all voltages, this snap over them may have been present at all times, but in some cases not sufficiently well marked to be heard above the continued hissing of the lightning arresters.

"After the preceding results had been obtained, the two power transformers were connected up with their high-tension windings in series, the point of connection between them being grounded, and with their low-tension windings in multiple. With this arrangement voltage was impressed on one of the circuits, power being supplied by the smooth armature at 7200 alternations. The voltage was run by means of the machine field to 90,000.

"As the power taken by the lines at this voltage overloaded the motor used to drive the generator, a span was cut out of the circuits at a little distance from the station, leaving about 500 feet of wire in them. The voltage was run up to 133,000 volts and held there for some minutes; but the current finally jumped from the outside terminal of each transformer to the iron, smashing the heavy glass tube with which these terminals were insulated."

DISCUSSION OF RESULTS.

The following is taken from Mr. Mershon's discussion of the results of his tests:

"There is evidently a certain critical voltage at which the loss occurring between wires begins to increase very rapidly; indeed, it seems as though there might be something of the nature of a polarization similar to that which occurs in the case of an electrolyte; that there is something of this nature in the case of air or other gases subjected to an electrostatic stress is well known, and it has been taken as an explanation of the fact that in the experimental determination of sparking distances in air a certain minimum potential is necessary to establish an arc, no matter how small be the sparking distance. Also, Varley has done some work on tubes containing gases. This work was done with a series of Daniell's cells yielding 300 to 400 volts. The voltage was impressed upon electrodes sealed into the tubes. He established the following facts: First, that each tube required a certain potential to leap across; second, that the passage for the current having been once established a lower potential was sufficient to continue the current; third, if the minimum potential which would maintain a current through the tube be P and the voltage varied to P plus 1, P plus 2, etc., P plus N, the current will vary in strength as 1, 2, 3, etc., N; P always meaning the lowest value at which the current will continue, and is less than that at which the current starts.

"If such a condition of affairs obtains in this case, the loss curves of the preceding sheets must be made up in two parts, one the loss over the insulators and cross-arms, the other the loss occurring through the air. The first part of the loss curve up to or near the point where the abrupt bend begins must be the loss over the insulators and cross-arms alone; beyond the point where such a bending occurs the loss curve must be made up of a combination of the two losses referred to.

"If the action which takes place in air is similar to that obtained by Varley, we might expect that both (1) the position of the critical bend on the loss curve and (2) the law which the loss follows above the bend would be affected by the form of the e. m. f. wave impressed upon the line, for the former (1) must depend, not upon the mean square of the voltage impressed upon the line, but upon the mean square of that portion of the e. m. f. wave which is above a certain critical voltage, and the latter (2) must depend upon the form of that portion of the e. m. f. wave above a certain critical voltage because, as Varley shows, the minimum voltage at which this peculiar loss begins differs slightly from the minimum voltage at which it will continue after the action has been established. If it were not for the latter consideration it would be comparatively easy to determine the equation for such loss, at least in the case of a pure sine wave, and it might be that there is a sufficiently small difference between the voltage at which this loss will begin and the voltage at which it will discontinue for such an equation to hold practically. That the loss depends upon the maximum value, if not upon the form of the e. m. f. wave, is shown by several of the loss curves in connection with their corresponding wave forms. This is particularly noticeable in one or two cases where the loss on two lines in multiple is less than that on one line, and although some of these comparisons will have to be made between curves taken on the two different wattmeters and are, therefore, not strictly comparable, they may be compared after such correction as is mentioned below in discussing the wattmeters. In any case the curves are comparable, qualitatively, as regards the position of the critical point.

"It might be objected that the results are rendered questionable by the curves in Fig. 7. The curves were taken under presumably similar conditions, except that one was obtained by means of the Thomson wattmeter and the other by means of the Weston wattmeter. This discrepancy is attributed to a charging current passing through the shunt resistance of the Thomson wattmeter. That the amount of capacity current necessary to produce the discrepancy is small appears upon the following considerations: In one case the loss obtained upon a circuit at 38,000 volts when using the Weston wattmeter is 90 watts, and under the same conditions, but using the Thomson wattmeter, the loss is 215 watts. The difference in the loss obtained by the two wattmeters is therefore 125 watts. The current is about 0.25 of an ampere. Now, 0.25 of an ampere if in step with the e. m. f. would give on the Thomson wattmeter at 38,000 volts a reading of 9500 watts; therefore the capacity current through the shunt resistance necessary to produce the discrepancy of 125 watts is 125 divided by 9500, or about 1.3 per cent. of the current in the shunt resistance. The shunt resistance has a value of 1,202,300 ohms; at 38,000 volts the current through it would be about 0.032 amperes; 1.3 per cent. of this, or 0.00416 amperes is that required to produce the discrepancy noted. In further support of this method of accounting for the discrepancy, the results obtained at different numbers of alternations using the Thomson wattmeter show a variation for different numbers of alternations of the losses below the bend in the loss curve, and which are thought to occur over insulators and cross-arms. There should be no variation in such loss for a variation in frequency.

"Any discrepancy occurring in the Thomson wattmeter by reason of a capacity current in its shunt resistance will be affected to a greater or less extent by change in the wave form.

"It is believed that all the phenomena connected with this work may be studied in a tube which has been partly exhausted. The work could then be done with comparatively low voltage and using direct current which would much simplify the measurements. The contents of the tube might be partially rarefied air or other gas, as the action would undoubtedly be similar in all gases. With such a tube might be studied the law of variation in distance and form of electrodes, also in material and surface of the same.

RÉSUMÉ AND CONCLUSIONS.

"It is undoubtedly true that the loss is made up of a loss over insulators and a loss between wires, and that the latter is the only loss worth considering.

"The loss between wires is not affected by any atmospheric conditions except precipitation. This statement of course must be taken as applying to such a climate as that in which the measurements were taken. The lines were seldom in fogs or clouds, and when they were, or when rain was falling, the moisture was of the purest. Near cities the loss would be undoubtedly much greater than that shown in these curves, because of the impurities, both in solution in the moisture of the atmosphere and in suspension.

"There will be for a given transmission a certain economical voltage, because while an increased voltage, with a given line wire, will reduce the loss in this wire by decreasing the transmission current it will also increase the loss between the wires.

"It is believed that attention to wave form is very important. The sine wave is undoubtedly the best as giving a stable form, and because of superior results with all kinds of apparatus. A flat wave would of course give less loss, but would not be stable, and as the nearest practical approach to a sine wave will not be perfectly stable, but will still contain some harmonics, it will be of advantage to keep the series reactance of the transformers and generators as low as possible.

"It is believed that 40,000 volts is perfectly conservative and safe as regards loss between wires for any ordinarily good wave form, and in a climate such as that in which the measurements were taken, *i. e.*, where the air and precipitated moisture are practically pure, 40,000 volts comes well below the bend in the loss curve even under the worst weather conditions.

"I can see no advantage of porcelain over glass, unless it be that of superior mechanical strength. The latter is rather a doubtful advantage. The ball from a heavy calibre rifle or revolver, such as are used in the Western country, will smash any insulator, whether glass or porcelain. Porcelain offers a more tempting mark, being white. As to hygroscopic properties, no difference could be discovered so far as these measurements were concerned. It will make little difference under running conditions whether the insulator be hygroscopic or not, as the small amount of power necessary to keep the surfaces dry will be insignificant. I say under running conditions, because in starting up a 'cold' line there is danger of breakdown if current is put on suddenly at full value instead of being raised gradually. As far as the resistance to piercing is concerned, glass is just as good practically at least as porcelain. It needs no electrical test to pick out a good glass insulator, which is one advantage of glass over porcelain.

"To sum up, glass insulators are cheaper, lighter, more easily tested and less likely to be shot at than porcelain; on the other hand, they have less mechanical strength.

"In every case, in my experience, where a breakdown has occurred, it has been on a cross-arm which was 'wind shaken' and 'weather cracked,' the current following the cracks. This leads to a curious result. The mark of the current will be on the surface of the arm for five or six inches, then disappear from the surface altogether for some inches, then reappear, etc. On cutting open the arm one sees how the current has followed the best path, dodging in and out. Rain and moisture probably settle toward the cracks, carrying salts from the body and surface of the wood. This forms a path of low resistance, especially in wet weather. For this reason I have in the plant of the Colorado Electric Power Company taken particular pains in treating both pins and cross-arms. The cross-arm treatment is such as fills all cracks and fissures as a section of the wood shows.

"This report would be incomplete without an acknowledgment of the assistance rendered in the work by the engineering force of the Telluride Power Transmission Company, headed by Mr. P. N. Nunn. Especial credit should be given Mr. A. L. Woodhouse for his faithful work and constant perseverance in the face of great discouragement."

HIGH-TENSION TESTS AT EAST PITTSBURG.

Laboratory tests and measurements on a small scale cannot take the place of tests under the conditions of practical service, such as those at Telluride. There are, however, many important elements which may be determined by laboratory measurements.

A high-tension line for testing insulators and making measurement upon the losses between wires was erected at the East Pittsburg factory in the fall of 1897. A number of the tests which have been made are here recorded.

(1) A test was made to determine whether the wave form of the charging current to the line was similar to that through a resistance, or whether it was modified by the loss component, the loss occurring only at the higher part of the e. m. f. wave. The current to the high-voltage line, at pressures varying from 30,000 to 60,000 volts, was passed through a coil possessing high self-induction. The e. m. f. upon the coil was measured by a voltmeter. The e. m. f. was also measured when a current of equal strength was passed through the coil, the line being short-circuited and a low e. m. f. applied. It was found that the voltage upon the coil was the same, within a small error of observation, in both cases, showing practically no difference in the wave form of the current under the two conditions. The current was from an armature giving practically a sine wave.

(2) The charging current to the line was measured under several different conditions when the current was obtained from a generator giving practically a sine wave. The results of measurements were compared with the currents as calculated by the theoretical formula. The last measurement in the table was made upon the Niagara-Buffalo line, with current from a Niagara generator, which differs slightly from a sine wave.

COMPARISON OF MEASURED AND CALCULATED CHARGING CURRENT TO PARALLEL WIRES. LENGTH, ONE MILE; 10,000 VOLTS.

Size of Wire.	Distance between Wires.	Frequency.	Measured Current.	Calculated Current.
			Amperes	Amperes
No. 8 B and S	21.7"	60	.0307	.028
8 B and S	48.0"	60	.0245	.0252
8 B and S	79.5"	60	.0234	.0238
8 B add S	127.5"	60	.0225	.0222
No. 8 and ground	120.0"	60	.0427	.0412
0.71" diameter	18" for ⅔ of distance 36" " ⅓ " "	25	.0176	.0176

A table giving the calculated charging current for a number of conditions will be found in Appendix B.

(3) The fall of potential around the wires was noted by tests made with spark-gaps. The wires 48 inches apart were connected to the high-voltage terminals and a spark-gap was placed between two idle wires, also 48 inches apart, placed about 21 inches below the first wires. A spark-gap consisting of brass terminals with a one-quarter-inch radius was placed between the two idle wires. When the gap was one-thirty-second inch the sparking began when the e. m. f. from the raising transformer was 26,000 volts. A gap of one-thirty-second inch requires an e. m. f. of 2200 volts to produce sparking. When the spark-gap was made eight-thirty-seconds inch (equivalent to 12,000 volts) the sparking began at 103,000 volts from the raising transformer. At intermediate points there is a fair proportionality between the spark-gap and the e. m. f.

In another test a spark-gap was placed between one of the idle wires and the adjacent wire of the live circuit. When the spark-gap was one-eighth inch (equivalent to 6000 volts) the spark passed when the e. m. f. was 17,500 volts, and when the spark was made one-quarter inch (equivalent to 12,000 volts) the sparking began at 33,000 volts. When the gap was three-eighths inch (equivalent to 16,000 volts) sparking began at 41,000 volts. When the gap was one-half inch (equivalent to 20,000 volts) sparking occurred at 49,000 volts. The e. m. f. did not differ greatly from a sine wave. These tests have an important bearing in connection with the running of telephone and other circuits adjacent to high-potential wires. It is essential that the wires of a high-potential circuit be spiraled so that each wire sustains the same relation as every other wire to the second circuit, in order that the effects of static induction may be neutralized.

(4) The effect of the size of wire upon the loss was investigated by running a pair of No. 28 brass wires 0.0126 inch in diameter and then replacing it by large rubber-covered wires. The rubber-covered wire was No. 7 B. & S. gauge 0.144 inch in diameter; the outside diameter of the rubber covering was 0.3 inch and the diameter over the braid was 0.35 inch. In each case measurements were made upon another circuit, which was unchanged during the different tests, and thus served for comparison. The results of these tests are shown in Fig. 13, which also gives the conditions when one fine wire and one wire of larger size, No. 8 B. & S., constituted the cir-

cuit. This comparison shows the very marked increase in loss when the fine wire is used. The loss is greatly decreased when the rubber-covered wire is used. The loss on the rubber-covered wire, however, increased considerably after the voltage had been raised and the rubber had broken down, thus permitting the current to pass freely to the outer surface of the insulation. It is quite probable that the loss would increase as the insulation became defective, until it was nearly equal to that of a wire having the same total diameter.

The measurements on wires of different size given in Fig. 13 are qualitatively correct, although some of the readings on which the curves are based were quite small, so that the absolute values may not be exact.

(5) The effect of the current in drying the surface of the insulators was illustrated in a test made during a rain. Upon applying 45,000 volts to a circuit the wattmeter indicated 116. After four minutes the deflection had decreased to 72, the current remaining the same. The e. m. f. was then increased to 60,000 volts, the wattmeter deflection increased to 155, and at the end of three minutes it had fallen to 138. The current was one-third greater than at the lower voltage, but remained constant while the wattmeter changed. The rain continued during the test, which shows, therefore, that the condition of the insulator is materially improved by the presence of the current.

(6) It was noticed that when there was a break-down upon the line and the current passed suddenly between wires over the surface of the cross-arm that there was a sparking between the terminals of the ammeters in the high-tension circuit across the surface of the instrument. This was further investigated by placing in circuit a coil of low resistance through which one ampere would be sent by about 1½ volts at a frequency of 125. A spark-gap was placed in shunt to this coil. A 2-inch spark-gap was also placed between the line wires. The voltage of the primary was gradually raised until at 35,000 volts the current passed across the spark-gap between the line wires. A spark also passed across a gap of three-eighths inch, shunting the small choke-coil. This test shows the remarkable suddenness of the rush of current when the short-circuit occurs due to the breaking down of the spark-gap on a high-voltage circuit. This phenomenon was observed by Mr. Mershon in choke-coils used in connection with lightning arresters at Telluride.

Running tests were made on four lines in multiple at high voltages. Each line consisted of two wires 1040 feet in length held by twenty-six insulators. The insulators were of various types of glass and porcelain, some of the ordinary form and some underhung. For hours at a time 100,000 volts or slightly more were kept upon the line. For about six weeks voltages ranging from 70,000 or 80,000 to 100,000 volts were kept on the lines for about eight hours a day. When there was rain the line would short-circuit and the voltage had to be reduced. During a driving rainstorm 48,000 volts were kept on the lines, and it may have required a considerably higher voltage to have caused short-circuiting.

(7) A high-tension wattmeter similar to the Thomson wattmeter at Telluride was used. To correct the wattmeter for the errors caused by charging current in the shunt resistance a condenser was placed in parallel to the shunt circuit of the wattmeter. This condenser should be so adjusted that the current through the shunt circuit of the wattmeter is the same that it would be if there were no condenser and the shunt resistance had no capacity. This permits the capacity current in the circuit to be shunted round the wattmeter by the condenser. The condenser in shunt to the wattmeter was capable of adjustment, and by varying its capacity the deflection could be made positive or zero or negative when current was delivered to a constant load. The proper adjustment was made by taking a comparatively low voltage, at which the charging current was very high in comparison with the loss, so that the loss was nearly negligible, and adjusting the wattmeter to indicate zero. At higher voltages, when there was a considerable loss, the error with this adjustment would be inappreciable. Certain variations with temperature and humidity were noted which would be explained by a variation in the capacity of the resistance, causing a variation in the charging current to the shunt circuit of the wattmeter. The high resistance for the shunt circuit was wound upon fuller-board plates containing brass stiffening pieces. Tests were made upon individual plates by measuring the capacity between the wire and the supporting strip of brass, and it was found that the capacity and the insulation resistance both varied with the amount of moisture in the fuller-board insulation. In order to prevent variations of this kind subsequent resistances were wound upon glass plates, which seems to be a very satisfactory form of construction.

TESTS AT NIAGARA.

Some measurements have been made upon the Niagara-Buffalo transmission line. There are two circuits of three wires each, one of which was in service and the other was available for tests. Each circuit consists of three cables each of 350,000 cm, approximately 0.7 inch in diameter. The cables are run on porcelain insulators, and are on the same cross-arm. Adjacent insulators are 18 inches apart and the circuit is spiraled, so that each of the three wires occupies the middle position for a third of the distance. Current from one of the 5000-hp generators was applied to the line through a raising transformer, by which the voltage can be increased by small steps to 100,000 volts. This transformer is part of a high-tension testing outfit which is described by Mr. C. E. Skinner in THE ELECTRICAL WORLD, March 5, 1898. The wattmeter is a Thomson inclined coil instrument with a high resistance shunt of German silver wire wound on glass glates. The ammeter is a Thomson inclined coil instrument, connected directly in the high-voltage circuit.

Measurements were made between the various pairs of wires, i. e., 1 and 2, 2 and 3 and 1 and 3; the current was found to be practically the same in each case; the loss on one of the circuits was slightly greater than that on either of the other two, on which the losses were about equal. The accompanying curve shows the measurements of current when two wires were connected and the measurement of loss; the latter measurements were made upon one pair of wires up to about 26,000 volts and then upon a second pair. The results are given in Fig. 14.

On another day measurements were made of the resistance between each wire and the ground, and corresponding measurements of loss were made by placing the high potentials between each wire and the ground. The measured loss was somewhat greater than the loss calculated by using the e. m. f. and the measured resistance. In these measurements, at voltages from 13,000 to 23,000 volts, the power factor calculated from the current and wattmeter measurements varied from about 4 per cent. to 6 per cent., so that a very small charging current in the wattmeter would produce a considerable error in the reading.

Some measurements were made upon a pair of fine wires, in which the wires were placed at different distances apart. No. 31 B. & S. gauge spring brass wire 0.0089 inch in diameter was used. The length of the parallel wires was 744 feet. They were suspended by light strings successively at 6 inches apart, 14 inches apart, and about 25 inches apart, the distance varying from 24 inches to 27 inches. The wattmeter readings are given in the curves in Fig. 15. The power factor of the measurements made above 100,000 volts is about 95 per cent., and is over 80 per cent. above 70,000 volts. There can be but little error in the wattmeter due to charging current in the resistance at these power factors.

The measurements on the Buffalo line were made by the writer. Those on the fine wires were made by Mr. E. M. Tingley, who conducted the tests at East Pittsburg, and rendered valuable assistance in the preparation of this paper.

POWER TRANSMISSION PLANTS IN OPERATION.

Beginning with the plant at San Bernardino and Pomona, which began operation in 1892, using 10,000 volts and transmitting 30 miles, a constantly increasing number of plants have been installed operating at 10,000 or 15,000 volts. In some cases there has been little or no trouble experienced with the transmission lines, while in other cases the experiences have been less satisfactory. The principal trouble seems to have been a poor grade or an insufficient size of porcelain insulator. In other cases the insulators, sometimes porcelain and sometimes glass, have given almost perfect satisfaction.

The superintendent of a power company which has been running fifteen months with about 15,000 volts reports that they "have had absolutely no trouble whatever of an electrical nature." Some insulators were broken because they had been used as targets by small boys or hunters, but only the outer petticoats were broken, and no short-circuits occurred, although in some cases insulators were in use for months with most of the outer petticoats chipped off. The distance of transmission is 12 miles. Porcelain insulators are used.

In another plant which has been in operation about a year and a half, employing 15,000 volts for a distance of nearly 30 miles,

there have been but three shut-downs on account of line difficulties. These were due to the breaking of insulators at a point where the line was spiraled. In one case the repair was made in half an hour, and in the other case a few minutes' interruption to the service was sufficient for repairs.

The line is regularly patroled, and if a defective insulator or pin is found the generating station is notified by telephone and the line is shut down for a few moments at noon. In one case two poles were burned by a defect in the insulators on the top of each. The poles burned to the ground, leaving the line hanging clear without any one at either the generating station or sub-station being aware of the fact.

Troubles have arisen on some lines by the burning off of pins by the passage of sparks from the outer edge of the insulator to the pin. These sparks make small holes in the pin no larger than a needle point, but after continuous sparking for some time the pin becomes entirely charred. An iron pin suggested itself as a remedy, but additional strains and liability to break down are liable when a conductor is placed within the insulator. The burning off of pins has occurred where small porcelain insulators are porous and the outside glaze is imperfect, while the glaze on the inside is good. When the porcelain is filled with water the current readily passes through it to the lower rim of the insulator and then sparks across to the pin. In one place which has been running for about three years some 250 pins burned off. The early insulators have been replaced by larger and better ones, and this defect has disappeared.

A 10,000-volt line which runs for a dozen miles or more within a few hundred yards of the Pacific coast has burned cross-arms on nearly every pole. The cross-arms near the ends of the line, which

Fig. 16.—Insulator Used at Provo for 40,000 Volts.

are away from the coast, are not burned. Usually the burning appears as a mere blackening of the cross-arm for a short space between the insulators, on one side of the arm. In some cases the charring is deeper, and appears on both sides. The side on which almost all of the burning occurs is the one toward which the winds come from the ocean, bearing the mist of salt water. The wire shows discoloration, and the iron braces for holding the cross-arms are in a few cases eaten through. Moreover, the cross-arms were green and full of sap when erected. The early porcelain insulators were porous, and have now been replaced, and the pins are of iron. The charging has ceased almost entirely since the new porcelains were put up.

It may be observed that in the plants which are herein referred to and in the experimental tests no mention has been made of insulators with cups containing oil for reducing the surface leakage. Insulators of this kind were used in the Frankfort-Lauffen experimental transmission line at 30,000 volts. Practically, however, the surface insulation is adequate without oil cups, and the principal duty of the insulator is to prevent the current passing over the surface and jumping to the pin or cross-arm, a matter with which the oil would have nothing to do.

Telephone lines are in use in a number of plants placed on the poles which carry the transmission wires. The telephone lines are usually placed some distance below the transmission wires and are crossed at frequent intervals. The telephones in general work very satisfactorily.

There appears to be practically nothing in power transmission in Europe using high potentials outside of Switzerland. The installation in Paderno in Switzerland is operating at 15,000 volts, the highest voltage which has been used in that country. The damp weather is one of the limiting factors. The insulators used are porcelain with a triple petticoat.

40,000 VOLTS IN COMMERCIAL SERVICE.

The highest voltage which is used for transmission is in the Provo plant of the Telluride Power Transmission Company in Utah, which transmits power 35 miles to the Mercur mills at 40,000 volts. Raising transformers are three in number and are connected in the star form. Each transformer has a capacity of 250 kilowatts. The middle points of both the high-tension and low-tension circuits are grounded. In general design these transformers resemble the transformers used in the high-tension tests at Telluride, the design and construction having been under the direction of the same man in both cases. The line extends from Provo at an elevation of 4500 feet to Mercur, at 2000 feet above Provo, and the line reaches an extreme height of about 10,000 feet above the sea level. Three miles of the line are strictly mountain construction. The lightning protection is afforded by choke-coils and Wurts non-arcing metal arresters. The insulators are of glass. The design was based on the tests at Telluride and they were made specially for this plant. The form is shown in Fig. 16. The insulators are held on special pins of oak which are thoroughly paraffined. The lower part of the insulator is 5 inches above the cross-arm.

In dry weather there has been no difficulty whatever in operating. The insulators do their work as effectively as could be expected if the voltage were only a few thousand volts. When everything is

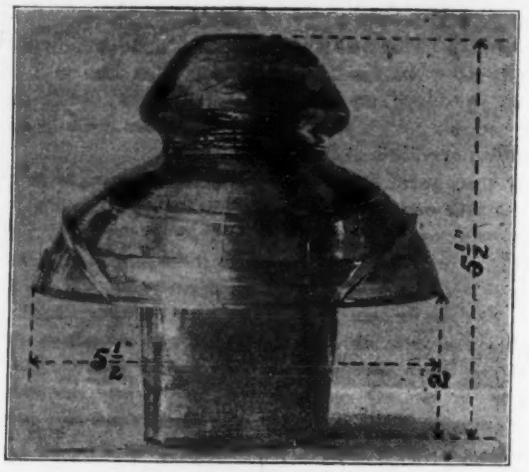


Fig. 17.—Insulator Used by Colorado Electric Power Company for 20,000 Volts.

dry the line will operate without difficulty, even if some of the insulators are off and the wire rests upon the cross-arm. When it rains there is sometimes trouble. It is indicated in the station by the ammeters giving quick swings, showing momentarily strong currents. Sometimes this is apparently a short circuit and blows a fuse. In every case when there has been trouble on the line it has been in rainy weather, and broken insulators have been found which located the trouble. It is certain that in most cases these have been previously broken by bullets, and in other cases it is probable that the insulators were likewise broken. It is believed, therefore, that had there been no intentional breakage of insulators there would have been no trouble upon the line since the plant began operating in February last. A few of the insulators near the station are not far from the overflow and are in a moisture equivalent to a rain all the time without doing any damage. Snow has often backed from the cross-arm up against the bottom of the insulator and around the first petticoat. It is usually found that the part of the insulator around and near the wire does not receive deposits of moisture or frost, but remains dry, the particles being repelled. At this plant current for about 700 horse-power is carried through three fuses of copper wire 0.01 inch in diameter. Iron wire is used on a branch line for transmitting about 100 horse-power for about three miles.

This plant has been in operation in winter and in summer, "in thunder, lightning or in rain," the sole supply of power for the

enormous De Lamar mines and mills, at Mercur, and is a happy and fitting consummation of the high-tension tests described in the beginning of this paper.

LIMITATIONS OF HIGH-VOLTAGE TRANSMISSION.

The important commercial question is: To what distance can power be transmitted? The relation between distance and voltage is well known. The same weight of copper can transmit with equal efficiency the same power to any distance provided the voltage is increased directly as the distance is increased. The limiting commercial ratio between voltage and distance is easily found. If the distance be 3 miles per 1000 volts and the loss 16 per cent., the cost of copper is about $20 per horse-power. The interest on the latter investment is about $1 per year. A distance in miles equal to three times the number of thousand volts may therefore be covered without an excessive annual charge per horse-power for copper. The limits to the voltage which are practicable depend principally upon the insulator and upon the loss between wires.

The two fundamental requirements are dielectric strength sufficient to prevent puncture, and a size and form which will prevent the passage of the current around the insulator. A given insulator will be adequate for a higher voltage where the atmosphere is comparatively pure and dry than it will be under other conditions. The rapid progress which has been made in the design and construction of insulators during the last few years will doubtless provide an insulator which will accommodate the highest voltages that can be used due to other limitations. The insulator, therefore, while remaining the critical point in a transmission system, will probably not determine the limit of practicable voltages.

The loss between bare wires at high voltages seems to determine a positive limit beyond which the voltage cannot be increased. This loss is subject to variation due to diameter of wire, distance between wires, and wave form of the e. m. f., but the variations which may occur under favorable commercial conditions locate the point of increase of loss about 50,000 or 60,000 volts. Under favorable conditions this may be raised somewhat, but it is not probable that any material increase can be made.

The amount of power to be transmitted involves some interesting commercial limits. There are certain elements in a transmission which do not vary greatly with the amount of power transmitted. Thus, the charging current to the line will be practically the same whether the wire will transmit 1000 horse-power or 100 horse-power. If the charging current happens to represent 300 horse-power it would be insignificant in one case, but for the smaller output it would require generating apparatus several times that necessary for the actual power.

It is not mechanically practicable to use wires as small as would be sufficient, in so far as conductivity is concerned, for transmitting a small power. For example, a No. 7 copper wire, which is as small as is ordinarily used, if employed in a three-phase circuit 50 miles in length will transmit over 1000 kilowatts at 40,000 volts with 10 per cent. loss. If only a few hundred kilowatts were to be transmitted the cost per kilowatt would be excessively high, and on the other hand a lower voltage could be used without undue loss. In some cases, indeed, where a high voltage is used for small power, as for example on a branch circuit, an iron telegraph wire would have ample conductivity. In other cases an aluminum wire could be used to advantage, as an aluminum wire of the same conductivity as a copper wire has only about half the weight, and possesses greater mechanical strength in comparison to its weight.

It may also be noted that high-voltage transformers cannot be economically built for small output, as the insulation spaces required are so large. The cross-section of the copper is often not more than 10 or 20 per cent. of the area of the opening in the iron. The cost per kilowatt increases very rapidly when the size of transformer falls under a few hundred kilowatts.

The overhead transmission line has been considered, and its limitations are the insulating strength of the insulator and the losses through the intervening medium. In a cable or a conduit the insulation must be provided continuously instead of at points a hundred feet apart. Rubber covered cables are made for 10,000 and 20,000 volts, but it is quite possible that it will not be commercially practicable to make cables for much higher voltages. The effect of continued electric stresses on the insulation of the cable, which is an unknown factor, may prove to be a very important one. A conduit composed of a pipe containing oil, in which the wires are separated by glass tubes, has been proposed. Many mechanical difficulties arise in construction of this kind; the cost is high and the action of continued high voltages on solids and liquids opens a field which is little known. A suitable insulation on the wires on high-voltage lines may enable higher voltages to be used than can be used with a bare wire.

Liquid air with its high insulating properties and the low temperature and consequent high conductivity which it would give to a conducting wire may enable us to use air insulation in a new way.

High voltages have been referred to in this paper with perhaps undue familiarity. Familiarity with high voltages is not one which breeds contempt. A voltage which can produce sparks several inches in length, which can be felt through several feet of air, which causes hissing sounds, which produces luminosity and which in a confined room generates strong odors of ozone, is one which creates profound respect. Dangers and difficulties accompany it, and the highest intelligence, vigilance and excellence must be employed to avoid accident and insure success. While ordinary types of construction do not seem to reach their limitations until some 50,000 volts is reached, and pressures of this order have been and are in regular use, nevertheless they are not to be used indiscriminately or where they can be avoided. There are difficulties enough in handling 15,000 and 20,000 volts. As the pressure is raised the liabilities to trouble increase at an alarming rate. It is, however, a fact that these voltages have been and can be used, and also that no new or modified methods of transmission will be required before 50,000 or 60,000 volts can be employed for distance up to 150 or 200 miles.

Profits of Alternating-Current Central Stations.

BY T. M. MESTON.

The most interesting problem confronting central station managers is how to increase the net revenue of the plant so as to make a more satisfactory balance sheet to present to stockholders at the annual meeting. Any line of policy that promises to result in a larger gross revenue without adding in the same proportion to labor and expense is consequently a gain in net profits.

The most important debit items in any central station are interest on investment, taxes, salaries and maintenance of pole lines. These charges are fixed by the conditions surrounding each individual plant, and do not, in any case, permit of being reduced to an extent that would materially affect the results of the year's business. Many managers, very properly, will not consider reducing some of these charges even as far as possible, feeling that too great economy in the matter of salaries and maintenance would be unwise policy for reasons that need not be entered upon at this time.

The writer has watched the development of alternating-current central stations with a great deal of interest, and is more and more impressed with the fact that most stations allow a great deal of revenue to escape them by lack of intelligent efforts to secure customers that are easily within their reach. The only practical remedy lies in the establishment of day circuits for power users in connection with intelligent and persistent canvassing to see that the merits of electric power are understood by all classes of people who can use power.

Many managers will stop here and say, "This is all very well in theory, but I have tried it and the results compelled me to abandon the project." But in spite of this view a day circuit can be made to pay in almost any town of over 5000 inhabitants. The opportunities for this power business are almost unlimited, but, like every other good thing, it requires hard work to start it going. Once started it will, like the proverbial snowball, continue to grow from its own momentum.

Some of the uses that occur to the writer are: Clothing factories, family sewing machines, dentists, lathes, jewelers, doctors (for operating Holtz machines), coffee mills, forge blowers, organ blowers for churches, pumps for houses where water supply is taken from wells and stored in tanks. Probably there is not a single station manager who cannot think of as many more right within his reach. A great many managers will say, "We run a 500-volt circuit for this purpose," but upon reflection they will see that this is at best a subterfuge, and is the most expensive way of attaining the results desired.

The greatest economy can only be procured in any business by reducing everything in connection with that business to a standard as far as possible. This point is now being recognized by central stations in the large cities, and what is probably the largest single-

phase station in the United States is running all classes of service from the same machine. This company operates incandescent light, series arc and power all from the same machine, and is intelligently pushing its power business, paying special attention to small users, as they can often be supplied with sufficient power for their needs without changing transformers, wiring, etc. Every small motor thus added is a source of revenue which is practically net profit.

A few years ago this plan would not have been practicable owing to the lack of a reliable single-phase motor. This objection can no longer be raised, as several makes of these motors are now on the market, and they are, in many ways, better than direct-current motors.

For small purposes the simple induction type is probably the best, as the absence of commutator renders them particularly suited to operation by inexperienced persons. The drawback to this type is that the load must be thrown on after the motor has reached speed, or the motor must be given a little assistance at start. This objection is practically negligible in sizes under one-half horse-power. Sizes one-half horse-power and over must be provided with some automatic starting device, usually consisting of a commutator which is short-circuited after the machine reaches speed, when the motor will carry a full load running as an induction machine. As the commutator is used for only five to ten seconds each time the machine is started, the trouble it might cause is practically eliminated.

Another great advantage over 500-volt circuit lies in the freedom from danger, which often deters the layman from taking advantage of electric power when he can only procure it in the 500-volt form.

As an incentive to the weak-kneed brother to look into this matter, the writer will say that he was much surprised to hear of a manager in a remote Texas town of less than 4000 inhabitants who was running a day circuit in summer. The writer expected, of course, that the venture would be a failure, but the man engineering the matter was a true hustler and he kept at it actively for about four weeks, and after that time his day circuit was a paying feature of his plant. This, of course, was only a summer circuit, but it was in a town of extremely small size. In view of this instance will any manager of a plant in a town of 10,000 or over maintain that he cannot make profit on a day circuit all the year round?

The only additional expense of a day circuit is coal and day attendance, the main items of cost not being affected at all.

Our grandfathers did not feel the need of kerosene and electric light until some one educated them to appreciate better things, and central station managers must educate the layman to depend on electric motors instead of less adaptable sources of power.

The writer believes that along the lines indicated above lies the solution of the success or failure of every alternating-current station, and would be pleased to see some active discussion of this matter conducted by some of the trade papers.

The Conductivity of Aluminum.

BY EDWIN F. NORTHRUP.

The following tests of the conductivity of some aluminum rods manufactured by the Pittsburg Reduction Company were recently made with considerable care. Some of the specimens tested were marked by the manufacturers as pure aluminum and others as alloyed with certain percentages of copper.

A potentiometer method slightly different from that usually employed was adopted partly on account of its accuracy and partly because the instruments employed had been previously carefully standardized by the writer.

Fig. 1 is a diagram of the connections.

The method consisted essentially in balancing two equal potentials against each other. In one circuit was a Thompson balance (previously calibrated by a voltmeter test), storage cells, a variable slide resistance to adjust the current to one-fourth ampere, and ten one-tenth ohm coils of a Queen-Anthony bridge connected in parallel. This bridge had been previously compared with a Nalder 10-ohm standard. Knowing the current by the balance to an accuracy of one-fifth of one per cent., and the resistance r to an accuracy of one-tenth of one per cent. or less, the potential drop over r was known to within an accuracy of certainly one-fifth of one per cent.

The aluminum rods were connected in series in another circuit with another Thompson balance which would read 2½ amperes to within an accuracy of one-fifth of one per cent.

A delicate D'Arsonval galvanometer and a key K were placed between these circuits as indicated, and p p', the contact points, were mounted on a steel rod so that the distance between them could be varied and accurately measured. The distance between these points was then changed until on touching them to the aluminum rod no deflection was observed on the galvanometer G. The method was sufficiently sensitive to indicate different resistances at different portions of the same rod due to the varying thickness of the rod itself. The test was made in a room of nearly constant temperature, and the current through the rods caused a scarcely appreciably rise in their temperature. This temperature was 26.9° C.

Proper corrections were made for the known error and temperature of the resistances r. The diameters of the rods were measured in several places by micrometer calipers. The conductivities were all reduced to the conductivity between the opposite faces of a centimetre tube and compared with the conductivity of a similar cube of pure copper at 27° C. The value taken for this was one divided by 0.000,001,767. In actual practice the percentage conductivities of the different specimens of aluminum were calculated by the formula:

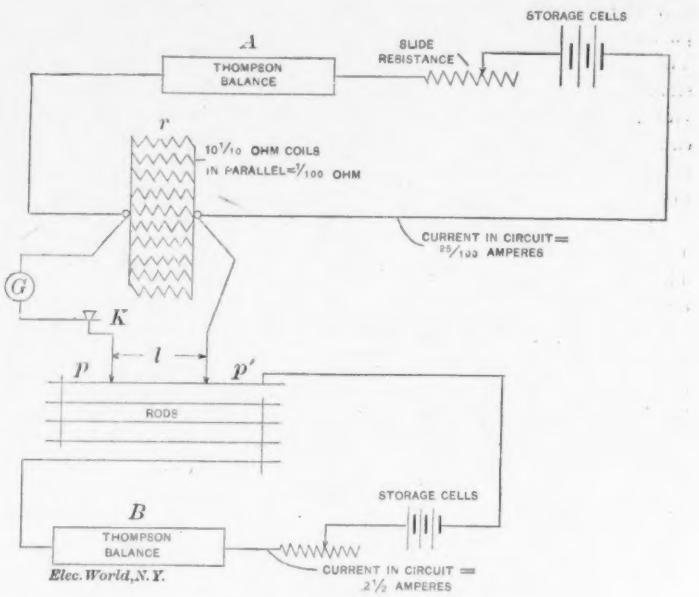


Diagram of Connections.

$$K = \frac{.000,001,767\ l}{0.785\ 4\ D^2 R}, \text{ where}$$

K = percentage conductivity of aluminum compared with copper at the same temperature as that of the aluminum, l = distance in centimetres between contact points on aluminum rod, D^2 = square of diameter of aluminum rod, and R = resistance of aluminum rod between contact points. R, of course, $= \frac{e}{c}$, where c is the current (2½ amperes) measured by one balance and e is the known drop over the resistance r.

The following table exhibits the character of the specimens tested and the results obtained:

Character of Specimen.	Length of Rod, l, Necessary to Balance.	Cross Section in Square Centimetres.	K = Per Cent. Conductivity.
Pure al.	46.10	0.13184	61.59
Pure al.	29.00	0.08302	61.50
0.75% copper.	67.75	0.1165	56.37
Pure al.	73.46	0.2105	61.45
*0.5% copper.	71.43	0.2704	58.16

*Two-tenths of an ampere in circuit through known resistance for this specimen, 25-100 ampere for the other specimens.

It is interesting to note that alloying copper, a better conductor for an equal cross section than aluminum, reduces the conductivity of pure aluminum.

The writer believes that these results can be relied upon by users of aluminum to within certainly one-half of one per cent., and probably a little closer.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE
AMERICAN AND FOREIGN
By Carl Hering

Dynamos, Motors and Transformers.

ROTARY CONVERTERS. S. P. Thompson. Lond. "Elec. Eng.," Nov. 11.—The beginning of a reprint in full of his recent paper before the Inst. Elec. Eng. After giving a table of the twelve principal conversions which can be accomplished between continuous and alternating currents of one, two and three phase and different voltages, he begins a discussion of those machines which convert continuous into alternating currents of one, two and three phase and the reverse; he limits himself to such machines and mainly to that form in which the armature contains but one set of windings with a commutator at one end and contact rings at the other, the same winding serving both to receive the primary and to generate the secondary current; this he calls a rotary converter, or more briefly a converter, the word transformer being applied to stationary apparatus. A table points out the relation between the number of contact rings and the use to which such generators may be put with respect to the phase relations of the currents. Another table gives the voltage on the alternating-current side, that on the continuous-current side being 100, the data being given for different numbers of contact rings. Another table shows the corresponding currents for an output of 10 kw. He then begins the discussion in detail of how the current, in the act of being converted from alternating into continuous or the reverse, flows through the windings of the armature; this he claims has not heretofore been considered in detail in any publication. With the aid of a number of diagrams he then shows clearly what the currents will be on the alternating and the continuous current sides, in a simple concrete case—namely, that of an ordinary armature to which two contact rings connected to two diametrically opposite points of the winding are added. The reprint is to be continued.

ENERGY IN SHORT-CIRCUITED ARMATURES. Roessler. "Elek. Zeit.," Nov. 10.—The first part of a long article in which he discusses the distribution of the current and the energy consumed in what is known as the squirrel-cage armature of alternating-current motors invented by Dobrowolsky and consisting of an iron cylinder with copper wires running through it near the periphery, all being connected together at their ends by copper rings. Such armatures are used with non-synchronous rotary field motors or non-synchronous single-phase motors which depend on a revolving field. In these the loss of energy in the armature winding not only affects the efficiency but is a very important quantity in the operation of the motor, as it determines the drop in speed for increasing loads; this diminution in speed is to the speed at no load as the amount of energy lost in the armature is to the total energy; the calculation of these losses is therefore of importance, as is also the distribution of the currents in that armature. He shows how to calculate the distribution of the current and the energy losses for the forms of armature occurring in practice. What occurs in such armatures is very complicated, but the theory in general is simple if it is assumed first that the resistance of the connecting rings and then that the resistance of the rods may be neglected. The description of the method does not admit of being abstracted, but some of the results may be of interest. He shows that if the resistance of the rings is zero a current will flow in each rod, independent of their number, the number of poles and the shape of the field—which is equal to that which would flow in that rod if its ends were connected with zero resistance. If the resistance of the rings is only a hundredth part of the resistance of the rods, the mean value of the current will be reduced to more than half; the torque will be reduced in the same proportion, as this depends on the product of the current and the field strength; for the same torque one armature would therefore have to have double the slippage of another similar one. With a large number of poles the armature current is only diminished to a slight degree. Not only the resistance of the rings but also the intermingling of the different currents depending on that current and the number of poles will diminish the total current. In general it may be said that this diminution will become less, the less the resistance of these rings or the greater the relation of the number of poles to the number of rods, for the same resistance of the rings. A table gives the distribution of the current in an armature of a certain kind.

INDUCTION MOTORS OF VARIABLE SPEEDS. Niethammer. "Elek. Zeit.," Nov. 10.—Multipolar non-synchronous motors for alternating currents sometimes show the property of running at a speed of one-half, one-third, one-fifth, etc., of their normal speed, and tend to maintain that speed. In the present article he explains the cause of this phenomenon as based on the magnetic relations and the arrangement of the windings. He shows that the rotating field is of the nature of the sum of several rotating fields of different periods. In conclusion he states that for rotary field motors, switching devices for the windings can be constructed on the principles which he points out, which will enable the motor to be run at quite different speeds; one switch in general will give two different speeds. For simple alternating-current motors in which the regulation would be in the armature winding, the switching arrangements would be somewhat complicated.

TESTING TRANSFORMERS.—"Elec. Eng.," Nov. 24.—A reprint of some illustrated instructions issued by a manufacturing company showing simple methods for testing and caring for transformers.

Lights and Lighting.

REGULATING ARC LAMPS.—"Elek. Rundschau," 15, p. 107; abstracted briefly in "Science Abstracts," Oct.—A description of a new method of regulating lamps in groups of three or more in series. Immediately behind a resistance, "arranged in series with and at the supply end of the mains supplying the group," is put a relay coil in parallel with the mains; this relay opens and closes a circuit containing a series of shunt coils acting in conjunction with the feed mechanism of each of the upper carbon holders; this feed mechanism in each lamp is also controlled by an independent coil arranged in parallel with the arc; when the catch controlled by the relay and the shunt coil, and that controlled by the independent coil, are both out of engagement, the lamp will feed, but not otherwise. The feeding of each of the lower carbons is similarly controlled by two catches, one actuated by coil in series with the arcs and the other in series with the independent shunt coils controlling the upper carbon of each lamp. A diagram of the connections is reproduced in the abstract.

INCANDESCENT SAFETY LAMPS. Courriot and Meunier. "Comptes Rendus," Oct. 17; abstracted in "L'Eclairage Elec.," Nov. 12, and more briefly in Lond. "Elec.," Nov. 11.—They show that an incandescent filament is incapable of producing a gas explosion; they filled an incandescent lamp with that mixture of marsh gas and air which has the greatest explosive power; the current was switched on and the bulb then filled with the explosive mixture; the glow then diminished rapidly except at one point, where the filament eventually broke; no explosive effect was produced. The explanation of this behavior appears to be that the gas is gradually burnt up without explosion, and when the spark occurs at the rupture there is no longer an explosive mixture in the bulb. To obtain an explosion it is necessary to break the filament and produce a spark by shaking the broken ends until they collide.

SWITCHES FOR SIGN LAMPS.—"Elek. Zeit.," Nov. 10, and "Elek. Anz.," Nov. 10.—A brief, illustrated description of the automatic switch for lighting and extinguishing lamps used for making up the letters of a sign or advertisement. The switches are operated by an eight-hour clock.

NERNST LAMP.—"Science," Nov. 18, reprinted in the "Elec. Rev.," Nov. 23.—A short article by Smith, from a recent description in a German daily paper; it is accompanied by two illustrations showing suggestions for heating the incandescent rod. The material he uses is magnesium oxide, which does not become a conductor until it is heated, after which it becomes "a perfect conductor" and emits a brilliant white light while the current passes. The preliminary heating may be made by placing it in the focus of a reflector on the inside of which is a spiral wire of platinum, which is brought to incandescence by the current. Another illustration shows a device, which has already been described, in which the body is heated electrically by radiation from a coil, from which it is afterward withdrawn magnetically. The same journal contains a short communication from Heidelberg (Germany) by Cooper, in which he states that Nernst has been developing and perfecting his inventions, and that "his researches have been crowned with such success that we may look forward to the early appearance of the finished lamp, and perhaps the confirmation of the most sensational rumors." He states that if the material is heated above 3000° C., or 6000° Fahr., which is far above the melting point of platinum, a very weak current is sufficient to keep them in an intensely luminous condition; either direct or alternating currents may be used, and the magnesia is little injured by use; the only difficulty lies in the method of heating the substance to make it a conductor. He adds that "the work is, however, progressing, and those who know the ability and courage of the inventor are confident that he will succeed."

ARC LAMP. Ross. "Can. Elec. News," Nov.; reprinted in "El'ty," Nov. 23.—An article reviewing recent improvements, with special reference to the enclosed arc lamp. For interior illumination, and in many cases for outside lighting, he claims that this lamp has decidedly the advantage, which has been recognized in the larger cities of the United States. A table gives the efficiencies of different arc-light systems.

Power.

SHAFTING V. DIRECT DRIVING.—Lond. "Elec.," Nov. 11.—An editorial discussion, with special reference to the recent paper of Langdon. When a number of shafts have to be driven there

can be no question of the advisability of using electricity from a single centre in place of long lines of shafting or a number of separate engines and boilers. It discusses chiefly the merits of the two methods of distributing the power in the shaft itself. Langdon showed that 72 per cent. of the energy supplied to the main shafting was lost in transmission and that such a case was a frequent occurrence. The loss of energy, however, should be compared with the cost involved in direct driving by motors; such a comparison is made and the figures are given, showing that in spite of the low efficiency of the shafting in that particular case there is still a saving in cost. It is therefore said that in shops in which machines are all small it is advisable to use larger motors driving shafting; a point is reached, however, as the power becomes greater when it is more economical to use a single motor driving a group of tools through a single short line of shafting; it is thought that about 5 horse-power is a suitable unit. In a large shop with heavy tools it is undoubtedly more economical to do away with the shafting altogether. The well-known advantages of the electric method are then enumerated. It is concluded that tools should be grouped into units when small, and separately driven when large, although this should not be applied too rigidly. Some small tools are sometimes advantageously driven by their own motor. The rage for very small motors is a mistake.

PRINTING PLANT.—"Elec. Eng.," Nov. 24.—An abstract of a discussion of Damon's paper (see ELEC. WORLD, Nov. 12). Cutter referred to the control of printing press motors; in such plants there is a considerable difference of opinion as to the desirability of using two circuits of different voltages for obtaining a wide variation in the speed; with one voltage it is necessary to use armature resistance to get a speed variation over the 25 per cent. which varying the field will give; but this resistance in the armature circuit is fatal to good regulation with varying loads. He mentions the importance of providing for the discharge of the field circuit of a shunt motor when it is opened. Damon described a lock device used to keep the pressmen from running the presses at less than the proper speed; a device is put on the controllers whereby they will not lock at anything less than the full speed for which they are set, while the controller may be used for starting and stopping, during which operation, however, the controller handle will have to be held. Roe expressed the opinion that a great number of speeds is not called for by practical printers, but in this printers seem to differ.

SHOREDITCH DUST DESTRUCTOR.—Lond. "Elec. Rev.," Nov. 11.—Some editorial remarks in which attention is called to several points and some estimates are made. It is concluded that there must be defects in the design and construction of the steam-raising plant. The value of combined plants is already being quietly demonstrated elsewhere, while the Shoreditch results are being given undue and premature prominence.

MUNICIPAL ELECTRICAL SUPPLY. Gibbings. Lond. "Elec.," Nov. 11.—The continuation of his long serial. He enumerates the chief advantages of the electric motor and considers briefly the cost of working as compared with gas, oil and steam, giving figures. He also gives a table of a sliding scale of charges for electric power, based on six months' use.

LOSS IN TRANSMISSION LINES.—Lond. "Elec. Eng.," Nov. 11.—Several answers to the question what considerations should determine the permissible loss in the line wires of a transmission plant.

POWER FOR ELECTRIC CURRENT IN PRUSSIA.—"Zeit. f. Beleucht.," Nov. 10.—A table giving the amount of power used for generating electricity in Prussia for each year from 1891 to '98.

ELECTRICITY IN AGRICULTURE.—Lond. "Elec. Rev.," Nov. 11; reprinted in "El'ty" (N. Y.), Nov. 23.—An abstract of the article noticed in the "Digest" Nov. 12.

GROWTH OF ELECTRIC POWER TRANSMISSION.—"Elec. Eng.," Nov. 24.—Some curves and data given by the General Electric Company showing the growth of power transmission as far as the installations made by that company are concerned.

TESTING POWER PLANTS. Benjamin. "Engineer," Nov. 15.—Abstracts of a recent lecture before the Electric Club of Cleveland. He describes briefly how to find the coal and water consumption per horse-power per hour.

WASTED FUEL. Bruton. "El'ty," Nov. 23.—A short article in which he endeavors to show how fuel is wasted in central stations.

Traction.

ELECTRIC TRACTION ON RAILROADS. Lanino. "Elettricita," 17, p. 64; abstracted briefly in "Science Abstracts," Oct.—He discusses the application of electricity for heavy railroad work. With steam locomotives the limit has been reached, the best types developing 1800 horse-power and weighing 154 pounds per horse-power; he therefore looks for progress in the electric motor, this being the lightest motor known; its weight, he thinks, can be reduced to 22 pounds per horse-power, and the absence of reciprocating parts removes all limit to the ultimate speed. He thinks the Heilmann locomotive will never prove superior to the ordinary steam locomotive, as the extra weight (the weight is 220 pounds per horse-power) will outweigh the advantages.

HAMBURG.—Lond. "Engineering," Nov. 11.—In the continuation of the long, illustrated description of the works and products of what was formerly known as the Schuckert Company, a well-illustrated description is given of the two railway lines in Hamburg and Altona erected by this company.

AUTOMOBILE MOTORS.—Lond. "Elec. Rev.," Nov. 11.—A brief, illustrated description of a motor to be used with direct chain gearing from both ends of the spindle Lightness in weight, great starting power, high efficiency and small space are the chief features claimed.

MULTIPLE-UNIT TRACTION SYSTEM. Cravath. "Elec. Eng.," Nov. 17.—A short reply to the recent article of Shepard (see "Digest" Nov 19). He disclaims having made any attack on the Sprague system; this system, he says, stands without a practical competitor for elevated roads on which a schedule of 15 miles per hour and over is to be obtained with trains of over four cars and stations about 2000 feet apart; he does not question the wisdom of its adoption on that Chicago road. For trains of four cars and less and for schedules of 17 miles per hour and under, that system and the locomotive systems come into competition in elevated service. Ir his previous statement about the lower efficiency of small motors in that system he referred to the time after acceleration when they are working on the friction load only, as distinguished from the acceleration. The acceleration should be as rapid as the traction on the drivers will permit and motors able to do this are very inefficient on the subsequent light load when the train is in motion. The energy to accelerate in the multiple-unit system will be less than that required by a locomotive to accelerate more slowly to a higher speed necessary for the steam schedule; but it is possible that this difference may be more than compensated for by keeping the current on in the multiple system, after the train is up to speed, thereby resulting in a greater waste than with a locomotive. The comparative efficiency of the two systems in watt hours per car mile depends much on the motorman; drifting is more essential to success on that system than with the locomotive. Some errors in his and in Shepard's remarks are pointed out. He cannot see why the cost of the installation of the power plant is less for rapid acceleration than for lower acceleration; while the watt hours used in acceleration are less with the multiple-unit system than with the locomotive for a given schedule, the maximum current is more by a large amount; several maximums may come at the same instant, resulting in high peaks. The extra investment in apparatus might, however, be compensated for by the watt-hour consumption.

ACCUMULATOR TRACTION. Krueger. "St. Ry. Rev.," Nov. 15.—A long abstract of his paper read at the Geneva meeting of the Tramway Union, and noticed in the "Digest" some time ago. He gives some data obtained from experience on the Hanover line, where the mixed trolley and accumulator system is used. Among other figures he states that the grid of a battery plate is made to last through six repastings, or about 150,000 miles; the cost of filling the negative plates with new paste is $18.20 per car, and the positives $169.55. During a period of two years, in spite of unfavorable relations, the cost of maintenance and renewals of the batteries has been only 0.81 cent per car mile. The average lives of the batteries in thirty-seven cars was 23,417 miles, that of the positive plates being 24,528 and that of the negatives 23,321 miles.

CHICAGO.—"West. Elec.," Nov. 19.—A short article on some innovations on the trolley lines in that city. One of them has a vestibule train consisting of a smoking car, with motors, and a regular coach as a trailer, with only one conductor. On one system only wooden trucks are used. A different form of ventilating the car is also mentioned.

SURFACE CONTACT SYSTEM. Johnson. "Elec. Eng.," Nov. 24.—The beginning of a reprint of a recent paper in which, after a brief introduction describing several systems, he describes the Johnson-Lundell system. It is a surface-contact system in which the contacts are made alive by the car passing over them.

CONDUIT SYSTEMS. Hedenberg. "El'ty," Nov. 23.—An illustrated article, being a brief, historical description of the development of conduit systems for railways.

ELECTROLYSIS OF WATER PIPES. Brown. "St. Ry. Rev.," Nov. 15.—A reprint of the whole of his paper, an abstract of which was noticed in the "Digest" Nov. 19 and Oct. 22.

RAILWAY RETURN CURRENTS. Fleming. "St. Ry. Rev.," Nov. 15.—A reprint of a large portion of his Brit. Assn. paper, which was noticed in the "Digest" Oct. 15.

MEASURING THE RESISTANCE OF STEEL RAILS.—"St. Ry. Rev.," Nov. 15.—A reprint of the short, illustrated article noticed some time ago, showing how the resistances of rails is measured in a manufacturing establishment in England.

NEW ZEALAND. Cicott. "St. Ry. Rev.," Nov. 15.—A short article calling attention to the possibilities of electric traction in that country.

Installations, Systems and Appliances.

BREAKDOWN AT BRIGHTON. Dallas. Lond. "Elec.," Nov. 11.—An account of a similar occurrence (see "Digest" last week), which helps to explain the cause of the minimum cut-outs opening. Four machines of 150 kw in an installation in the United States were running in two sets on three-wire mains, each being provided with a minimum cut-out; all four were nearly loaded when one minimum cut-out acted, owing to a fault on one of the machines and another fault on the main of that same pole, thus short-circuiting the cut-out, which then acted. The other machine on the same side was then overloaded, running the faulty dynamo as a motor, the two being on the same side; the field of the dynamo then dropped, owing to the engine slowing down, and its minimum cut-out worked, thus cutting out all the lights on that side. After that

the machines were separately excited. An entirely different type of minimum cut-out was afterward used with great success.

The Brighton breakdown is also discussed in the Lond. "Elec. Rev." It is thought improbable that the cut-out of the injured machine should have operated until the speed of the machines had been reduced on all the others sufficient to cut them out, but supposing this to be the case, as was suggested, the substitution of return cut-outs would not improve matters, as they would be equally liable to stick. Another possible solution is that the short circuit caused a sudden rise in the current in all of the cut-outs, which induced a momentary current in the solid iron core in the opposite direction, thus partially or wholly depolarizing it for an instant, and they would then operate; this could be avoided by using a laminated core.

VIENNA. Neubeck. "Zeit. fuer Elek.," Nov. 6.—An illustrated description of the plant for the tramway company in Vienna; it is for supplying light and power, but does not seem to include power for traction purposes. One of the illustrations is a good diagrammatic representation of the somewhat unusual system of circuits. The primary system of distribution of the current is according to the three-wire system with a bare neutral wire, and the generators therefore consist of two direct-current, fourteen-pole dynamos of 650 volts in series, each pair being driven by one engine. In the two outer wires there are also two equalizing accumulators of 1110 ampere hours each, of eighty cells, in series; the regulation of these is automatic; from these the current is divided into six pairs of feeders, going to six sub-stations, each of which has two batteries of accumulators and a rotary transformer for charging them; from each of these sub-stations the distribution is by means of the five-wire system, with a voltage of 240 between each two wires. The transformer consists of a four-pole dynamo operated with a 480-volt current, and coupled to a four-pole dynamo, which delivers current of 480 volts in two circuits; the neutral wire of this system is also uninsulated; the incandescent lamps are operated at 240 volts. There are also arc lamps and a number of motors for power purposes. (The description of this somewhat odd system is not very clear.)

FOLKESTONE.—Lond. "Elec.," "Elec. Rev." and "Elec. Eng.," Nov. 11.—An illustrated description of the lighting plant. The continuous-current three-wire system is used, with 420 to 460 volts on the outers, the dynamos being connected only to the outer wires; besides these there are a booster, a battery of accumulators and a balancer.

NURNBERG. Scholtes. "Elek. Zeit.," Nov. 10.—The conclusion of the very long, detailed description of this plant, noticed last week. A number of tables showing the operation and costs are given.

RUNNING COSTS OF PRIVATE PLANT.—Lond. "Elec. Rev.," Nov. 11.—Details of the running costs of a private plant at the Blackpool winter gardens.

HAMILTON MUNICIPAL PLANT.—"Can. Elec. News," Nov.—A reprint of the report by Domville to the City Councils of Hamilton, Ont., on the cost of installing and operating a municipal lighting plant.

HAMBURG.—"Zeit. f. Beleucht.," Nov. 10.—A long extract from the report on the operation of this station during the past year.

CHICAGO.—"Elec. Eng.," Nov. 24.—A brief description of some new work in the Harrison Street station.

ECONOMIES IN SMALL LIGHTING PLANTS. Roberts. "West. Elec.," Nov. 19.—A reprint of a long paper read before the Ohio Elec. Assn., in which he shows how to operate most economically stations which are in existence, as distinguished from the question of how to design them. It is followed by the discussion.

WORKSHOP HINTS. Fells. "West. Elec.," Nov. 19.—Brief descriptions, with illustrations, giving practical hints for repair shops.

Wires, Wiring and Conduits.

HIGH-TENSION LINE. Semenza. "Elettricita," 17, p. 166; abstracted briefly in "Science Abstracts," Oct.—A brief description of the Paderno line. There are two sets of three-phase lines; by putting all the load on one set, repairs can be made on the other, as the generators are capable of giving a higher voltage to compensate for the greater drop. There are two separate pole lines, and the wires on each one "are divided into three lines, so as to diminish the self-induction;" the existence of three lines, however, tends to produce idle currents in wires of the same phase, if any dissymmetry exists in the relative positions of the wires; the most symmetrical disposition was found to be the following: "The wires are fixed, four on one side and five on the other side of the pole, at such distances that any three consecutive wires are at the vertices of an equilateral triangle, the phases being in the order 1, 2, 3, 1, 2, 3, 1, 2, 3, alternately on each side of the pole."

MOISTURE ON HIGH-TENSION INSULATORS. Stuart-Smith. "Jour. of El'ty," Sept.—A short article in which he shows that the tendency of an electric charge is to prevent the accumulation of moisture on the surface of a charged body; the presence of the charge and the tendency to increase the surface result in a repulsive force between the water molecules, and if the voltage is sufficiently high they will fly off; this action will continue until every vestige of moisture disappears. When the voltage is sufficiently high, as is the case in modern transmission lines, any further accumulation will be impossible, since the water will be dissipated as fast as it is condensed; this action will increase with increasing voltage, and the hygroscopic quality of the surface will be practically nullified when the voltage is a little greater than that necessary to produce a rapidity of dissipation equal to the rapidity of condensation. With the voltages used on transmission lines it is probable that no surface will condense moisture as fast as the force of repulsion can dissipate it even in a fog. The character of the surface is therefore practically immaterial, and glass is at no disadvantage on account of its property of condensing moisture; its hydroscopic power may be ignored when very high voltages are used. This is commented on editorially in the issue of Oct., under the heading of "The Burial of a Bugaboo." His explanation is said also to give a plausible reason why it was found very difficult, and sometimes impossible, to start the Provo-Mercur 40,000-volt transmission plant during rainy weather, although when once started the heaviest rains do not affect the operation of the line. The problem which remains to be solved is a means for cleaning insulators of the dust that cakes on the windy side. Insulators on long telegraph lines are cleaned periodically to prevent leakage; in some cases it is even necessary to take down the insulators and clean them as often as three or four times a year; if this is necessary for telegraph lines the same procedure may be found a remedy for some of the difficulties in extremely high-voltage transmission.

CABLE CONDUIT.—"Elec. Eng.," Nov. 17, and "West. Elec.," Nov. 19.—A brief, illustrated description of a new section of conduit which has just been laid in the Niagara Falls power house. It is built of vitrified tile, is 1230 feet long, embedded in cement.

Electro-Physics and Magnetism.

DURATION OF ROENTGEN-RAY EMISSION. Morize. "Comptes Rendus," Oct. 17; "L'Eclairage Elec.," Nov. 5; abstracted in Lond. "Elec.," Nov. 4.—He devised and carried out a method of determining the duration, and believes it to be capable of great accuracy. He fixed the photographic plate at the end of the shaft of a high-speed motor and photographed a slit when the motor was at rest and when it was moving, and found the images drawn out sideways. The results show that each current impulse in the primary of an induction coil corresponds with several successive impulses of the rays; successive images of decreasing intensity are produced, separated by uniform intervals; on some plates four images can be traced. The durations ranged from 65 to 107 millionths of a second, the mean being 82; the intervals were 0.00033 second on an average.

DIFFERENCE BETWEEN ROENTGEN AND CATHODE RAYS. Geitler. "Wied. Ann.," No. 9; abstracted briefly in Lond. "Elec.," Nov. 4.—He endeavors to bring out clearly the essential difference between them by a study of their electrification or ionization properties. Roentgen rays are absolutely incapable of conveying a charge, although they can equalize opposite charges by rendering the air between them conducting. His arguments are in favor of regarding Roentgen rays as essentially different from cathode rays. This is also the view taken in the new theories of Roentgen rays and the English wave theory, in which cathode particles, when stopped, generate single-wave impulses; also the Dutch corpuscular theory, which regards Roentgen rays as discharged cathode particles.

X-RAYS IN WAR.—Lond. "Elec. Eng.," and "Elec. Rev.," Nov. 4.—A brief, illustrated description of a demonstration of Roentgen-ray field practice in the British Army.

POTENTIAL GRADIENTS IN VACUUM TUBES. Wiedemann and Schmidt. "Wied. Ann.," No. 10; abstracted briefly in Lond. "Elec.," Nov. 11.—A lengthy investigation of potential gradients as affected by the source of current, by heat, magnetism, light and photo-luminescence of the gas itself. The results were practically the same whether an influence machine or a battery of accumulators was used as the source; the luminous appearances are characteristic of the discharge potential; the heating effects in the glowlight are quite out of proportion to the potential gradient there; in the positive light the whole of the energy given out by the discharge is converted into heat.

DEFLECTION OF DISCHARGES BY MAGNETIC FORCES. Henry. "Phil. Mag.," Nov.—A long paper giving the results of experiments undertaken to find the explanation of the change produced in the magnetic deflection of the electric discharge in rarefied gas, when the gas is changed.

ELECTRIC WAVES. Lord Kelvin. "Phil. Mag.," Nov.—A short paper giving the substance of his recent Brit. Assn. paper. The subject is "Continuity in Undulatory Theory of Condensational-Rarefactional Waves in Gases, Liquids and Solids, of Distortional Waves in Solids, of Electric Waves in All Substances Capable of Transmitting Them, and of Radiant Heat, Visible Light, Ultra-Violet Light."

The Lond. "Elec.," Nov. 11, gives a brief abstract of this paper. It states that this throws a flood of light on the connections which exist between all types of wave motion, from those of sound to Hertzian and light waves, and to luminous and ultra-violet waves. The imaginary apparatus is briefly described in the abstract, and it is shown how first a low sound will be produced, then a shriek, then light, and so on.

POLARIZED ELECTRO-MAGNETIC WAVES. Waitz. "Wied. Ann.," No. 10; noticed briefly in Lond. "Elec.," Nov. 11.—He describes his researches with the polarization of electric waves by a metallic slit. He found the energy transmitted by the slit undergoes a periodic increase and diminution as the length of the slit

is enlarged. The minima are very pronounced and closely approach zero; the maximum occurs when the wave at the slit "has the same length as the resonator and electrometer combined." The first minimum occurs at a length of slit double that of the first maximum.

COHERERS. Aschkinass. "Wied. Ann.," No. 10; abstracted in Lond. "Elec.," Nov. 4.—The results of investigations made to assist in finding the nature of coherer actions; he criticises the views held by Lodge.

TEMPERATURE COEFFICIENTS OF DIELECTRIC CONSTANTS. Pellat and Sacerdote. "Comptes Rendus," Oct. 17; "L'Eclairage Elec.," Nov. 5; abstracted briefly in Lond. "Elec.," Nov. 11.—They determined the dielectric constants of paraffin and ebonite at various temperatures. They show that in charging a condenser at constant temperature the charge as usually calculated must be multiplied by a factor depending upon the temperature.

ALTERNATING CURRENTS IN BRANCHED CIRCUITS. Lyle. Lond. "Elec.," Nov. 11.—The continuation of his mathematical article on currents in branched and in mutually inductive circuits produced by harmonically varying e. m. fs. (see "Digest," Nov. 5). In the present portion he gives some examples of the application to the transformer of the principles which he described in the previous portion.

APPLICATION OF IMAGINARY QUANTITIES. Guilbert. "L'Eclairage Elec.," Oct. 29.—A long, mathematical article on the application of imaginary quantities of the problem of a uniformly distributed capacity.

CAPACITY OF POLARIZATION. Grimaldi and Platania. "L'Eclairage Elec.," Oct. 29; abstracted at some length from an Italian journal.—They measured the capacity of polarization of very thin metallic membranes, corresponding to very short, known periods of time.

RESISTANCE AND LONGITUDINAL STRAIN. Cantone. "L'Eclairage Elec.," Oct. 29; abstracted from "Accad. Lincei.," 6, p. 175.—He describes experiments with silver and nickel and obtains proportionality between the forces and the elongation in the variations of the electrical resistance; beyond a certain limit, however, it is no longer true; the ratio of the increment of resistance to the total resistance, divided by the ratio of the increment in length to the total length, is nearly a constant.

CONDUCTORS IN ELECTROLYTES. Stark. "Wied. Ann.," No. 10; abstracted briefly, with a diagram, in the Lond. "Elec.," Nov. 11.—He shows a method of representing the occurrences at the surface of a metallic plate immersed in an electrolyte through which an electric current is passed; the curves show the distribution of the current.

THEORY OF HALL EFFECT IN A BINARY ELECTROLYTE. Donnan. "Phil. Mag.," Nov.—A reprint of a Physical Society paper. He calculates what effect might be expected theoretically.

ELECTRICAL SOLAR HYPOTHESIS. Delta. Lond. "Elec. Rev.," Nov. 4.—Reproductions of the results of some magnetic observations which tend to substantiate his electrical hypothesis of the solar system.

ENERGY OF A MAGNETIC FIELD. Pellat. "L'Eclairage Elec.," Oct. 29.—An Academy paper deducing some formulas based on the quantity of heat absorbed or given out in order to maintain the temperature constant during the charge.

INTERNATIONAL MAGNETIC CONFERENCE.—Lond. "Elec., Nov. 4.—A reprint of the report of the Committee on Terrestrial Magnetism and Atmospheric Electricity, appointed in 1896. It refers entirely to terrestrial magnetism, and makes a number of recommendations regarding such observations. It refers briefly to the disturbance caused by electric railways, and recommends that special precautions should be taken to protect the observatories from the effects of railway currents.

POWER TRANSMISSION THROUGH AIR. Trowbridge. "Elec. Rev.," Nov. 23.—A reprint of the article noticed in the "Digest" last week.

INDUCTION COIL CONDENSERS. Dell. "Elec. Rev.," Nov. 16.—Descriptions of some experiments, which are a continuation of those previously noticed. He used an adjustable condenser with the interrupter locked. He found variations of light obtained in a Crookes tube by varying the capacity of the condenser; also that there was a certain capacity which was best.

Electro-Chemistry and Batteries.

COMPARISON ACCUMULATORS. Schoop and Benndorf. "Elektrochem. Zeit.," Nov. 1.—The conclusion of their long article (see "Digest" Nov. 12). They give similar results for the Oblasser accumulator and conclude with some general deductions and remarks. To compare the values obtained for different accumulators they reduce them to what they call a unit accumulator—that is, to one which would weigh 1 kg, the relative weights of the various parts remaining the same; (this is the same as is usually done when the figures are reduced to the various data per pound or kilogram). They construct some diagrams from the results, in which, however, they use three co-ordinates, the abscissas representing the voltage, the ordinates the time, and the third or Z-axis the current in amperes; the result is a surface instead of a line as usual. The properties of the accumulators are then shown by these surfaces; if the internal resistance is infinitely small and the depolarization capacity infinitely large, the surface will be parallel to the Z-axis; the less the other surfaces deviate from this, the better the accumulator. Similar surfaces representing the data obtained with the separate electrodes (with the aid of the cadmium electrode) are said to be even more interesting, and several are given; these are reduced to what they call the unit electrode. The results obtained from these three accumulators are then discussed. Some similar charging curves are also given, and are said to be of greater interest than the discharging curves. One of these shows that in all three systems the spongy lead electrode charges better than the peroxide electrode; the negatives also act better at the discharge.

RULES FOR ACCUMULATOR FACTORIES.—"Zeit. f. Elektrochemie," Oct. 30.—A reprint of the rules adopted by the German Government concerning precautions which should be taken in accumulator factories to protect the workmen against lead poisoning.

ELECTROLYTIC PRODUCTION OF IODOFORM.—"Elek. Anz.," Oct. 9.—Descriptions of several processes with which good results have been obtained.

ZINC ANALYSES. Paweck. "Zeit. f. Elektrochemie," Nov. 3.—A short article describing experiments made to find a reliable electrolytic method for a quantitative analysis of zinc. In one of these he used as a cathode an amalgamated zinc or copper plate, as an anode a perforated platinum electrode, the electrolyte being an acid solution of zinc. He also experimented with a cathode made of wire gauze amalgamated electrolytically. The results obtained seem to agree very well with the calculated value, and the zinc deposited was said to be very good. In the second method he used an unamalgamated brass wire netting for the cathode, the solution being slightly acid and containing potassium or sodium sulphate.

ELECTROLYTIC ANALYSES. Smith and Wallace. "Elektrochem. Zeit.," Nov. 1.—A brief description of a method for uranium and another for cadmium.

TIN. Cowper-Coles. "Elektrochem. Zeit.," Nov. 1.—A short article describing briefly electrolytic methods for purifying tin and obtaining it from its ores.

ELECTROMETALLURGICAL LABORATORY. Borchers. "Zeit. f. Elektrochemie," Nov. 3.—A short article describing recent additions to the laboratory at the high school at Aix-la-Chapelle, of which he has recently taken charge. It refers more particularly to the installation for experimenting with the electric furnace.

ELECTRO-CHEMICAL SOCIETY. Muller. "L'Eclairage Elec.," Nov. 5.—A continuation of the report of the papers read at the recent meeting of the German society.

WATER PURIFICATION.—"Elec. Eng.," Nov. 17.—A reprint of a short discussion in the "Eng. News." It is concluded that the direct treatment of water by the electrical current is of little value, but it is hoped that a coagulant might be produced electrolytically in preference to the chemical methods. The recent experiments in Louisville, Ky., showed that the cost of the electrolytic production of aluminum hydrate was not only excessive, but that the method was unreliable; but an iron hydrate could be produced much more advantageously and will be cheaper than commercial sulphate of alumina, but it could not safely be used at Louisville. Iron and aluminum are said to be the only metals available for electrolytic production of coagulants.

Units, Measurements and Instruments.

PHASE METER.—"L'Elec.," Oct. 29.—An illustrated description of the Dobrowolsky phase meter, a description of which was noticed several years ago. It consists of a coarse wire and a fine wire coil perpendicular to each other like in an electro-dynamometer, except that both coils are stationary, but in place of the needle there is a large disc of iron with a pointer, kept in position by a spring but capable of a slight rotation around its axis. The main current and the shunt current, if not in phase, produce a revolving field which causes the disc to tend to rotate; the amount of rotation, indicated by a pointer, is proportional to the value of the wattless component of the current; the graduation is empirical. The use of an iron disc makes the readings dependent on the frequency, and each instrument can therefore be used only for the frequency for which it has been calibrated; this would be overcome by the use of a copper disc, but the coils will then have to be much larger.

DETERMINING THERMAL AND ELECTRIC CONDUCTIVITIES. Straneo. "Accad. Lincei. Atti," 7, p. 197; noticed briefly in "Science Abstracts," Sept.—A mathematical paper showing how with simultaneous observations the thermal and electric conductivities of wires at high temperatures may be ascertained.

MAGNETIC UNITS AND MEASUREMENTS. Schmidt. "Zeit. f. Elektrochemie," Nov. 3.—The beginning of a short article written for metallurgists and foundrymen, explaining magnetic terms and properties, and showing how the latter are measured; also the results which have been obtained with iron, in so far as they interest foundry engineers.

HOW ACCUMULATORS SHOULD BE TESTED.—Lond. "Elec. Eng.," Nov. 11.—A reply to this question referring to whether constant current or constant potential should be used. The difference is pointed out and it is stated that the best method to adopt while testing is that method which is to be used for charging when the accumulator is in actual use.

Miscellaneous.

PRESIDENTIAL ADDRESS. Preece. Lond. "Elec.," "Elec. Eng." and "Elec. Rev.," Nov. 11.—The conclusion of his presidential address (see "Digest" last week). In discussing lighthouses he states that the introduction of electricity in English lighthouses has not been such an unqualified success; no new electric light has been installed on the coast of Great Britain since 1888, and there are only four such lighthouses on that coast; this is due chiefly to the great first cost and cost of maintenance; moreover the sailor cannot judge distances by it, as it is too brilliant in clear weather, while in bad weather it penetrates no better than an oil lamp. The subject of traction is then considered. Hamburg, he thinks, is one of the best trammed cities on the continent; the electric street railways are constructed by private enterprise under a lease, the municipality supplying the electric energy at a fair price. The trolley and conduit systems are briefly compared, the former being favored. The seriousness of the corrosion of pipes is mentioned, but he states that the remedies are simple, easily obtainable, and very effective. Electric traction, he thinks, must sooner or later be considered for the suburban traffic now carried by steam railroads. The transmission of power is briefly discussed, and a table gives the records of some interesting installations. The Lond. "Elec. Rev.," in a short article, takes exception to some of his remarks.

DEVELOPMENT OF ELECTRICAL ENGINEERING. Raworth. Lond. "Elec. Eng.," Nov. 4.—A long abstract of his presidential address before the Northern Society of Electrical Engineers. He points out the rapid development, including the whole range of all electrical practice, but it is chiefly of local interest, as it refers to progress in that country. It contains some statistics and data.

ELECTRICITY IN SWITZERLAND.—"Bul. Soc. Int. des Elec," Aug.-Oct.—Long, illustrated extracts from a report of an excursion to Switzerland made by some students in April. The extracts include a chapter on the regulation of turbines in which a number of forms are illustrated and described; a chapter on the different methods of distribution in general in which a brief reference is made to the continuous-current system, which is always at constant current, the generators being all in series and the motors being provided with special regulators; the system is of use exclusively where the source is a water-power of high falls, on account of the high speeds required. The distribution with diphase alternating current is discussed and a number of applications described; similarly for the three-phase current. There is a short chapter on electric traction and one on switchboards and accessory apparatus; another describes the visits to the Brown and the Oerlikon works; the last is on electro-chemistry.

ELECTRIFICATION IN PAPER MANUFACTURING.—"Elec. Tech.," Oct. 15.—A note stating that none of the usual methods for discharging paper which has been electrified during its process of manufacture have proved satisfactory, the reason being that the paper is not only electrified on the surface but throughout its mass, and that therefore after the surface has been discharged it will again be charged from the interior portions. The desired result has now been accomplished by providing large discharging spaces in which the surface of the paper is subjected to the action of a large number of discharging points, which, owing to their large number, discharge the paper during a longer period.

EFFECT OF ELECTRICITY ON PLANTS. Lemstroem. Lond. "Elec. Rev.," Nov. 4.—The beginning of a reprint in full of his recent Brit. Assn. paper, abstracts of which have already been noticed.

INSULATING MATERIAL. Andreoli. "L'Elec.," Oct. 29.—A short note calling attention to the fact that in England use is made of fish oil for insulating materials, a fibrous material being impregnated with heavy fish oil; this material is superior to vulcanized fibre and can replace ebonite. He has recently ozonized this oil, which thickened it rapidly; he thinks there is a great field for oil thus treated.

TURIN.—Lond. "Elec.," Nov. 4.—The continuation of the description of electrical exhibits, including illustrations of two alternators, an enclosed motor and an oscillometer, all made by Italian companies.

PARIS EXPOSITION.—"Elek. Zeit.," Nov. 10.—An editorial giving some information about this exhibition. The amount of power used will be about 20,000 horse-power, three-quarters of which will be used for electric lighting and one-quarter for power purposes. This is to be generated in only two boiler houses, one of which is to contain French and the other foreign boilers. All the power to be used is to be transmitted electrically; in each power house both the continuous current and single and multiphase alternating currents will be generated. The voltages of continuous-current dynamos are to be only 125, 250 or 500, and of alternators 2200 at a frequency of 50. The distribution of the currents will be in charge of the exhibition authorities; what machines are to be used has, it appears, been decided, but not published. Some further details are given, including the cost of power and the charging for coal.

VIENNA EXHIBITION.—"Zeit. f. Elektrochemie," Oct. 30.—The continuation of the illustrated description of the electrical exhibits.

BIOGRAPHICAL.—Lond. "Elec.," Nov. 4.—A biography, with portrait, of Latimer Clark, the inventor of the Clark standard cell, who died Oct. 30. The Lond. "Elec. Rev." and "Elec. Eng." also contain biographical notices. See also ELECTRICAL WORLD last week, p. 546. The "Elek. Anz.," Oct. 30, publishes a short biography, with portrait, of the late W. E. Fein, one of the pioneer electrical manufacturers in Germany.

HIGH-FREQUENCY CURRENTS IN THERAPEUTICS. Tesla. "Elec. Eng.," Nov. 17.—A reprint of a paper read before the Amer. Elec. Ther. Assn. in September.—While chiefly of interest to physicians, it contains some things of general interest, besides good diagrammatic illustrations of the various systems of producing high-frequency currents. One of the remarkable features of such currents is their apparent harmlessness, which makes it possible to pass large amounts of electrical energy through the body without pain or discomfort. The electrical actions may be divided into three classes, the statical or that depending chiefly on the magnitude of the potential; the dynamical, depending chiefly on the quality or quantity of the current, and thirdly, effects of a distinct nature due to electric waves. These three actions are generally coexistent, but one or the other may be made to predominate. Various methods of connecting the circuits are described with the aid of diagrams, and are briefly discussed. When one terminal of a high-frequency series is connected to ground, certain peculiarities will be noticed; it may be of some consequence which terminal is connected to the ground, as in high-frequency discharges the impulses in one direction are generally preponderating. One of the noteworthy features of these currents is the facility which they offer for conveying large amounts of energy to a body entirely insulated in space; currents strong enough to fuse may be passed through a wire entirely insulated at one end; this method affords great possibilities in the hands of the physician, and is discussed at some length; he does not think it impossible to convey to a human body or to give off in space, energy at the rate of several horse-power, while a small part of this amount applied to the human body in other ways could not fail to be injurious. He shows how by varying the period the points of highest potential of the secondary may be shifted along the terminal, and this point may therefore be brought to any part of the body or made to move through it; the body may by this method be subjected to several million volts without injury. With such high electrifications small particles adhering to the surface are torn off violently, and this is the case even with the toughest of the metals; he thinks this can be made use of by the physician as a substitute for a water bath. The inductive action of such high-frequency currents is discussed, both the electrostatic and the electrodynamic, and an illustration is given of an apparatus for producing these effects. He describes some experiments made to produce intense inductive action in a small space, and obtains some surprising results; when the end of a heavy bar of iron was placed within the loop it was raised to a high temperature in a few moments; a sheet of tin was fused instantly, the action being comparable to an explosion; the energy at that point may have been as much as 10 horse-power. He studied the effects of this action on living tissues and found that he could thrust his hand within the same loop and hold it there; he even held his head there, but there is danger in such an experiment; if a conducting path was so formed within the living tissue of the head it would be instantly destroyed, which would be accompanied by death; such a method of killing would be absolutely painless. The only explanation he can offer for the peculiar action is that the tissues are condensers. Pieces of metal embodied in living tissues could thus be heated, affording a possibility of sterilizing wounds or of locating bodies. Most of the results which he obtained are made possible only by the discharge of a condenser; to give an idea of such an effect he states that a condenser small enough to go into a vest-pocket may create pressures a hundred times greater than those produced by the largest static machine ever constructed; or used in a different way, currents may be obtained far superior to those in the largest welding machines; this is possible because the condenser can discharge in an inconceivably short time. In conclusion he describes a physician's instrument for generating and using such currents.

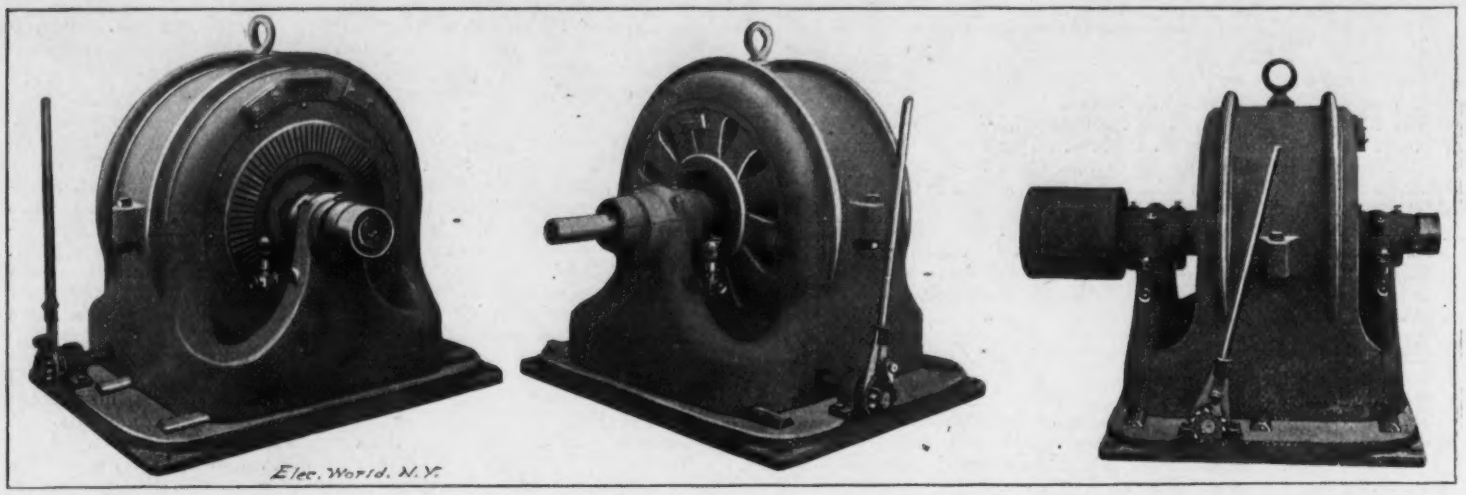
M'GILL UNIVERSITY.—"Can. Elec. News," Nov.—A short description of the new electrical equipment.

ELECTRICAL INVENTION. Rosenbaum. "Elec. Eng.," Nov. 17; "West. Elec.," Nov. 19, and at greater length in "Elec. Rev.," Nov. 23.—An abstract of a recent Franklin Institute paper on the status of electrical invention. Each of the main branches of the science of electricity is discussed and the inventions described which have been responsible for the development of the science. It will appear in full in the "Jour. Frank. Inst."

BIOGRAPHICAL. "West. Elec.," Nov. 12.—A long biography, with a portrait, of the late Charles H. Summers.

Telegraphy, Telephony and Signals.

PROTECTING TELEPHONE CIRCUITS FROM DANGEROUS CURRENTS.—"Elek. Zeit.," Nov. 3.—An editorial discussing the probable cause of the recent fire in the Zurich telephone central station. The switchboard was the 1893 model of the Western Electric Company; in this the subscriber's line is momentarily earthed in making the connections; a telephone line wire which broke fell across the trolley wire; it is calculated that a current of 25 amperes could then have passed at 500 volts, and this could maintain a continuous arc at the switchboard. This seems to have been the true cause; it might have been prevented by a fuse in the line circuit; another way of preventing it would be to introduce a resistance of 20 to 40 ohms in the earth connections. Another experience in Vienna is cited, and in this the current from the trolley



Figs. 1, 2, and 3.—General Elevation Views of Warren-Medbery Alternator.

wire crossing passed through one of the wires of a cable leading from the roof to the switchboard, starting a fire, due to a fault in the insulation. Such fuses should not only break the circuit, but should simultaneously earth either the outside or the inside circuit of the station, but even in this case the Vienna fire would not have been prevented. The fuses had best be placed in a chamber on the roof of the building where the wires enter, so that all the wires and cables in the building would be protected.

TELEPHONE CALL.—"Elek. Zeit.," Nov. 3.—An illustrated description of the method used in Paris noticed in the "Digest" Sept. 24. It is for the purpose of calling any one of a number of stations without disturbing the others.

TELEPHONE SWITCHBOARD. Dubreuil. "L'Elec.," Nov. 5.—A brief description, with some diagrammatic illustrations, of the new switchboard for 9000 subscribers which has just been installed at the station on Rue des Renaudes, Paris, the cost of which, including the erection, will probably exceed $200,000.

SUBMARINE CABLE VESSELS.—Lond. "Elec. Rev.," Nov. 4.—A complete list of those used in submarine cable work. There are forty-one vessels, with a gross tonnage of 64,615 and 8971 nominal horse-power.

SUBMARINE CABLE GRAPNELS. Bright. Lond. "Engineering," Nov. 4.—The beginning of an article in which he discusses and describes, with the aid of illustrations, the different forms of grapnels which have been used to a large extent in practice with complete success.

TELEPHONE SWITCHBOARD.—"Elec. Eng.," Nov. 24.—A brief description of a new switchboard which has been placed in the Harlem central station. This new board is said to be a great advance on the self-restoring drop system. The method used is known as the relay system, the incandescent lamp signals being operated by relays.

EVOLUTION OF THE TELEPHONE SIGNAL. Clausen. "West. Elec.," Nov. 19.—An article of a historical nature.

Warren-Medbery Inductor Alternators.

Among the foothills of the Adirondacks, less than 50 miles north of Albany and about 20 miles from Saratoga, is located the home of the Warren-Medbery Company, Sandy Hill, N. Y. The excellent train service from north and south, by the Delaware & Hudson Canal Railroad Company, puts Sandy Hill within easy reach of Boston, New York or Buffalo, and all Canadian points.

Much interest is displayed throughout the country by engineers and station men in the new types of inductor alternators manufactured by the Warren-Medbery Company, and it seems fair to suppose that this type of machinery is a favorite one in the modern electrical field by reason of the increasing demand reported by its manufacturer.

The Warren-Medbery Company is building a full line of single-phase alternating-current machines, of belt-driven type, adaptable to all forms of lighting service. The standard machines are wound for 1000 or 2000 volts primary, and machines of either voltage may be provided with a subsidiary armature winding for local lighting at any standard voltage, usually 110 to 220 volts, arranged for distribution by either the two or three wire methods. The practicability of subsidiary winding for station or adjacent property lighting is at once apparent both from the point of economy and safety, as the use and cost of transformers for short-range lighting are dispensed with, and the point gained that the station is not plunged in darkness, with the customary confusion, in case of the opening of the primary circuit in fuse, circuit breaker or elsewhere.

A machine equipped with a subsidiary winding is installed in a southern New York lighting station, where about 125-light capacity is provided for and used in the station and residence of the owner of the plant situated nearby. A machine operating in Mexico has a capacity in its auxiliary winding of 150 lights, which are distributed by the three-wire system, 220 volts between the outside wires, with the customary neutral arrangement.

The Warren-Medbery Company, recognizing the demand for machines of low voltage, to be used for local lighting or isolated plant work, is connecting its alternators in such a way as to give the full-rated output in kilowatts, at any desired voltage, between the terminals and for any system of distribution. A plant installed by this company in northern Kentucky is connected for three-wire distribution, so that there is a potential difference of 240 volts between its outside wires and 120 volts to the neutral from either of the outside wires, when the load on both sides of the system is equal. A novel method for compensating for unequal distribution, by reason of different load on the two sides, is used. It consists of an arrangement placed on the switchboard whereby it is possible to vary the connection of the neutral wire to either side of the true central point of the armature, thereby increasing the length of active conductor and consequently raising voltage on the heavily loaded side, while the voltage of the light side is decreased proportionately. A rheostat, in series with the alternator field, gives further and more delicate control of the voltage.

It has evidently been the aim of the designer of these machines, Mr. H. B. Warren, to combine every feature which his long, practical experience among station men and engineers would teach as desirable and thoroughly practicable, and to eliminate every feature likely to prove troublesome or not durable when in service.

The testimonials now in the possession of the Warren-Medbery Company, as to the performance of the machines, which have been in service for a considerable time past, prove the advantages of many of the original improve-

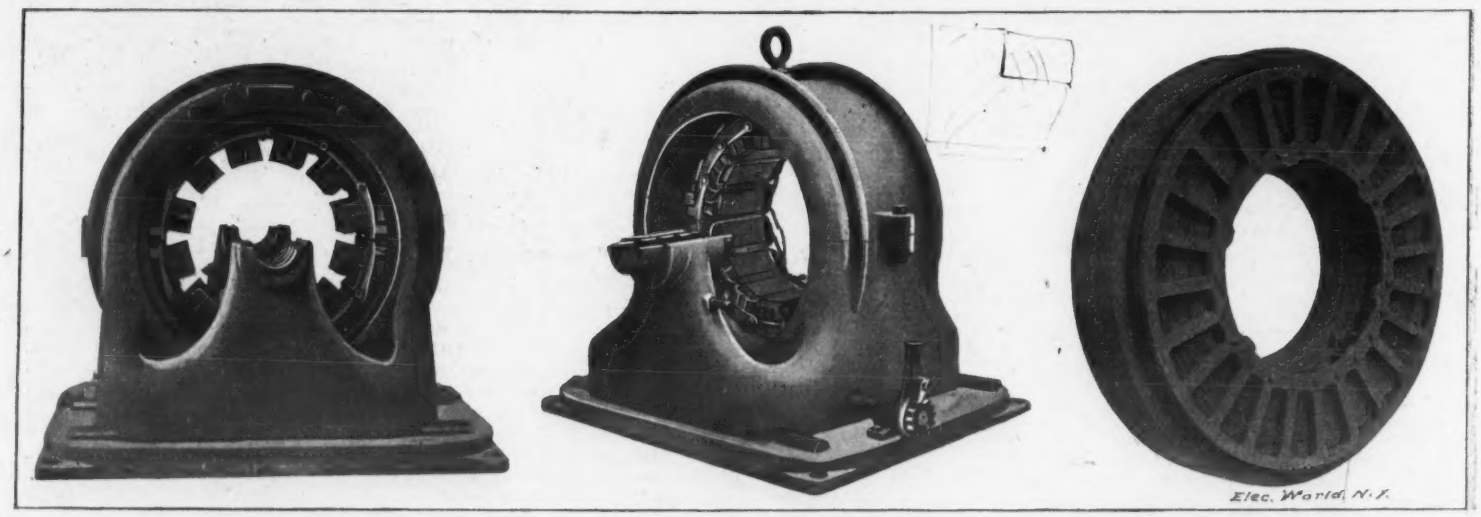


Fig. 4.— Uni-tooth Armature and Frame. Fig. 5.—Armature Wound. Fig. 6.—Annular Yoke.

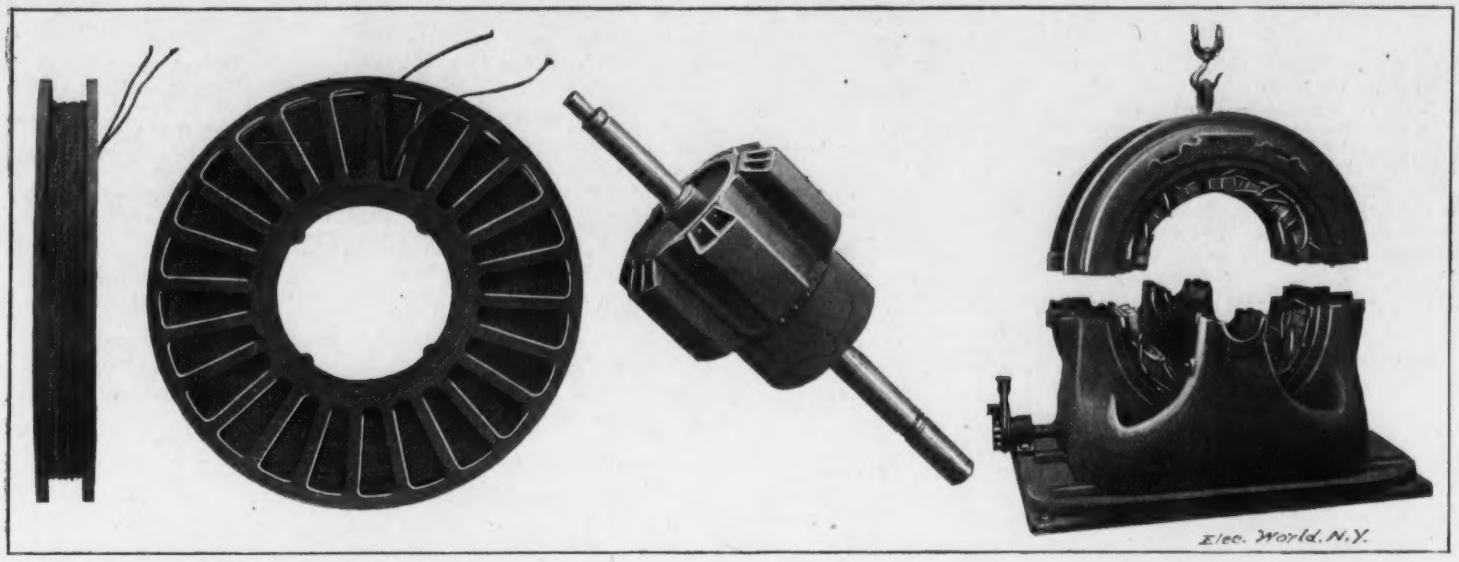


FIG. 7.—END AND SIDE VIEWS OF FIELD COIL. FIG. 8.—INDUCTOR. FIG. 9.—END VIEW OF MACHINE.

ments designed by Mr. H. B. Warren, which are embodied in the Warren-Medbery alternators. The utmost care has been taken in the working out of details throughout the entire machine, the idea having been to obviate all such parts as were fragile or not necessary to the good working of the machine, not, however, falling behind the foremost rank in regulation of economy.

In the illustrations shown herewith, Nos. 1, 2 and 3 are general elevation views of the Warren-Medbery alternator in its different positions. It will be noticed that such details as belt tightener and oil gauges have been carefully worked out to meet the approval of station men by reason of their simplicity and effectiveness.

The frame rests on three skid-ways of cold-rolled steel shafting, having nine footings of large dimension, thereby permitting the machine to move easily back and forth when it becomes necessary to tighten or slacken the driving belt. The skid-ways are set into the sub-base, carefully lined and anchored in position. The belt tightener consists of a screw, operated with a ratchet and pawl from the lever, causing the machine to advance or recede in a true line on the skid-ways, thus preserving the alignment between the dynamo shaft and the driving shaft.

Fig. 4 is an elevation view of the machine, showing the general structure of the stationary uni-tooth armature and frame. It will be noticed that the armature-coil slots are unusually deep and generous in proportion, giving this part the almost appearance of a field frame, thereby permitting the armature coils to be thoroughly insulated and set well back from the surface of the air gap, thus lessening the liability to mechanical injury, in event of chips or other foreign matter accidentally getting in between the inductor poles and the armature iron.

Especial attention is called to Fig. 5, showing the arrangement of the windings on the stationary armature. It will be observed that no clamps are used, and a strip of fibre only is required between the armature teeth to hold the coils and insulating troughs in position. The smooth bore seen on the inside of the frame, near the armature body, is intended to make contact with the outer face of the annular yoke, shown in Fig. 6. Station men having had experience with antiquated types of inductor machines, wherein it is necessary to remove the inductor to get to the field coil, will appreciate this feature in the Warren-Medbery machine.

If it should ever be necessary to remove the field coil for inspection or repair it is but the work of a few moments, and a very simple operation to remove the coil and yoke from the frame. It is further entirely practicable, in event of destruction of the field coil by lightning or accident, to wind a new coil without removing the old field coil or inductor. The process consists of loosening the field coil from the yoke and blocking the coil on the inductor, which is readily accomplished by means of a few wooden wedges; the coil will then turn freely with the inductor and the old wire may be unwound quickly; the new wire may then be wound on exactly as if the coil was mounted in a winding lathe.

Fig. 7 shows two views of the field coil. The frame on which the coil is wound is of brass and is lined in every portion which comes in contact with the coil with sheet fibre, treated to prevent absorption of moisture, and of such a thickness as to thoroughly insulate the winding from the coil frame. The structure of the coil frame allows of perfect ventilation and permits overloading the coil without danger to the insulation. Currents of air induced by the rotating part of the machine pass freely about the coil to the outer air by way of the yoke openings. The coils are proportioned for heavy overloads, and in no single instance has it been found necessary to replace a field coil injured by overload.

The inductor, the only moving part of the machine, is shown in Fig. 8. It is a solid steel casting, with a single ring of poles of laminated steel firmly held in place by being dove-tailed into grooves cut in the body of the inductor. The shaft, in bearings, is made extra large and long for the work required, thus insuring cool running and long life to bearings. The bearings are of the most modern construction, self-oiling from oil reservoirs of large capacity. The bearing sleeves are made solid and lined with a high grade of low-friction metal.

The bearing sleeves and supports for same are so designed that when it becomes necessary to move the sleeve the only process required is the removal of the bearing cap, allowing the sleeve to be turned and slipped endwise off the shaft. In the outboard bearing machines the centre-bearing sleeve is split to enable its being removed without withdrawing the shaft or taking down any parts other than the bearing cap of the centre bearing. The Warren-Medbery Company has devoted very careful attention to the subject of bearings, and it is safe to say that for accessibility and perfection of operation the bearings are in the front rank.

Fig. 9 shows an end view of the machine with the upper half lifted. This arrangement greatly facilitates assembling or installing the machine, and by reason of the fact that the machine may be shipped in so many parts it renders unnecessary the use of bridging or expensive temporary structures generally used in the installing of heavy machinery.

The Warren-Medbery Company believes that it is consistent with the best practice to test every one of its machines to full load for a considerable period of time, and to make a run at or above the guaranteed overload before permitting the machine to leave the shop. The company has at its disposal several hundred horse-power in a set of turbines operating under a 16-foot fall on the Hudson River, and also the most modern apparatus to simplify and facilitate the process of testing.

Through the columns of THE ELECTRICAL WORLD the Warren-Medbery Company earnestly invites all prospective purchasers of electric light machinery to witness tests employed in the construction of its machinery.

The two-phase 60-cycle generators manufactured by the Warren-Medbery Company are meeting with great praise from all concerned in their operation. The subject of two-phase machinery will be treated at length in a special bulletin to be issued by the Warren-Medbery Company at an early date.

The Westinghouse Gas Engine.

The ancient myth of the Greeks that Athene, the goddess of wisdom, sprang into being full armed from the brain of Zeus is being constantly disproved, even in its allegorical sense, by the experience and science of to-day. All our concrete embodiments of wisdom have grown by a process of evolution from small or crude beginnings to their present state of perfection. The Westinghouse gas engine is no exception to this rule. As long ago as 1886 Mr. George Westinghouse saw that there was a very promising field for a gas engine which should run with the steadiness of a steam engine, and he set several of his

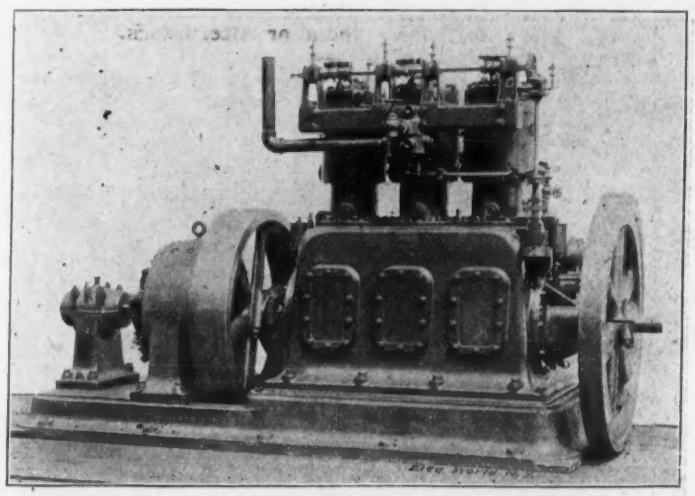


FIG. 2.—50-HP "ENGINE TYPE" GAS ENGINE.

engineers to work on the problem. They built several experimental engines and gained much valuable experience; and then the Fuel Gas & Manufacturing Company bought the patents which had been obtained, and pushed the work forward with more men and better facilities. Mr. Westinghouse gave it his personal attention, and a number of practical engines were built and sold. Soon, however, the business became too big for the limited facilities of this company, and it was transferred to the Westinghouse Machine Company in the fall of 1896.

The mechanical design of the engine was at that time thoroughly overhauled and made to conform to the ripe experience of the machine company in steam engine construction. Structurally the gas engine resembles closely Westing-

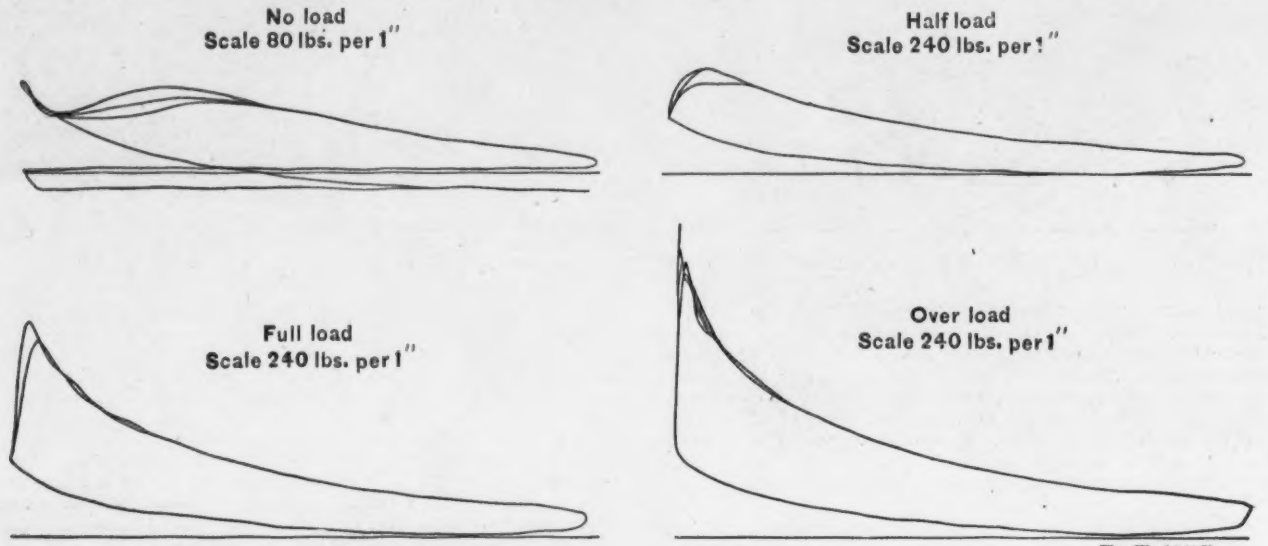
house standard steam engines, having the same vertical cylinders, single-acting trunk pistons and enclosed crank case. A complete line of sizes of engines was designed and the business put on a thoroughly commercial basis. To illustrate the thoroughness with which the experiments have been carried on, take the case of the 225-hp engine now doing regular commercial work (shown in Fig. 1), which was built as an experimental engine in the early days, and has, by a process of successive changes, completely lost its identity, for no portion of the original engine is left. Such readiness to try new and promising ideas has given the company an experience on which it can rely in designing new styles. It can well be imagined that a great deal of money has been spent in conducting such experiments, especially when it is realized that it is the Westinghouse policy to first build a big experimental engine, and from it get the data for designing a whole line of smaller one. The result has justified this foresight, for to-day the company is regularly selling engines ranging all the way from 10 to 125 brake horse-power, and is extending the range up to 280 brake horse-power. Step follows step, and a 650-brake horse-power engine has been built and installed in the power house of the Westinghouse Electric & Manufacturing Company for regular service.

These engines operate on a modified form of the Beau de Rochas cycle. They the clearance on the up stroke and ignite it near the top centre. The piston draw in a charge of gas and air on the first down-stroke, then compress it into then moves down during the second down-stroke under the pressure of the exploded gases, and these are exhausted during the second up-stroke. They depart from the Beau de Rochas cycle in that the incoming gas and air are throttled to a greater or less degree by the action of the governor, according to the load on the engine. This method of governing insures an explosion with every other revolution in each cylinder or one per revolution for the two-cylinder, and one each two-thirds revolution for the three-cylinder type, instead of a reduction of the number of explosions, as with the so-called "hit or miss" governors. The frequency and regularity of the impulses insure such steadiness of running that it is possible to mount a dynamo rigidly on the engine shaft and obtain perfectly steady electric light.

Fig. 2 shows an engine and dynamo of this type, which is on exhibition at the shop. The method of governing is very characteristic. The air and gas enter each through their own set of ports, and are mixed in the interior of the valve, and then passed on to the poppet inlet valves by way of the larger ports, which are not materially diminished by the motion of the valve. To provide for the variability of the gases in different locations the capacity of both gas and air ports may be varied by adjusting either half of the valve and thus proportioning the amount of gas and air taken in. The position of these adjustments is determined once for all when the engine is first started.

After being mixed and measured in the mixing valve the charge passes into the cylinders through poppet valves, which are mechanically opened at the proper time. These valves are mounted in small covers or bonnets, which makes it very easy to remove them for examination, but their construction is so simple that they require practically no attention.

The ignition is accomplished by means of the igniter shown in Fig. 3, which is strongly protected by patents. This igniter has two pairs of terminals, from either of which the spark may be drawn, and, as the change can be easily made while the engine is running, it furnishes an insurance against a shut down in case of accident to one pair of points. The electric current for the ignition may be obtained from either a battery or lighting dynamo or from a small dynamo installed for the purpose. This current passes through a choke or spark coil and then through the points in contact. At the proper instant the points are quickly separated, and the kick of the inductive coil produces a bright spark which causes the explosion. At the end of the stroke the poppet exhaust valves are lifted by cams inside the crank case and allow the burnt gases to escape.



Gas Engine Cards.

The accompanying set of cards taken from an engine show plainly the reason for the regularity of running, for they indicate a nice adjustment of the power of the explosion to the work required. The throttling of the admission below the atmospheric line shows clearly in the no-load card.

These engines are conservatively rated, for they are all tested in the shop up to a maximum or overload of at least 10 to 15 per cent. above their rating, and

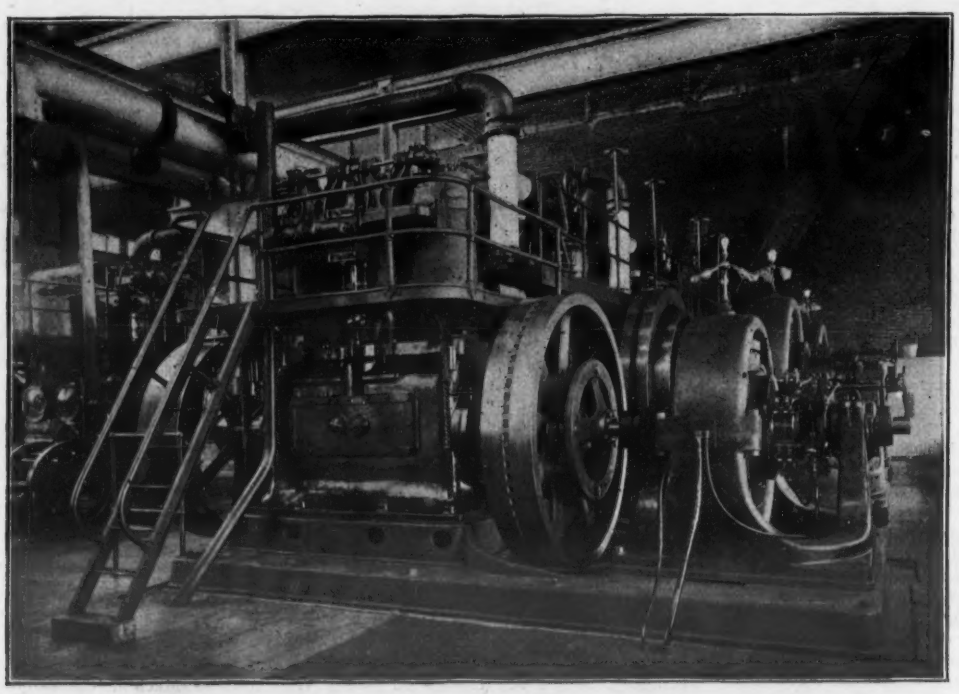


Fig. 1.—225-Hp "Kodak" Gas Engine.

Fig. 3.—The Igniter.

they are run on the testing foundation for a number of days and their behavior critically noted. The gas consumption is, in all cases, measured and seldom varies from the limits of 10 to 12 cubic feet of natural gas per brake hp-hour at full load.

Anyone who has had any experience with gas engines will be quick to ask about the starting of such large engines, and will be pleased to learn that it can be easily done by one man or boy, for all the larger sizes are provided with a small automatic valve which, when thrown into action, admits compressed air on every down stroke into one of the cylinders, whose regular inlet valve is, for the moment, thrown out of gear, and whose exhaust valve, through the medium of a movable starting cam opens each revolution. The cylinder, for the time, acts as an air motor, and drives the engine until the charges drawn in by the other cylinder or cylinders explode. Then the air is shut off and this cylinder thrown into normal action. The air is obtained from an air reservoir, which is charged by means of a small air pump driven by the engine.

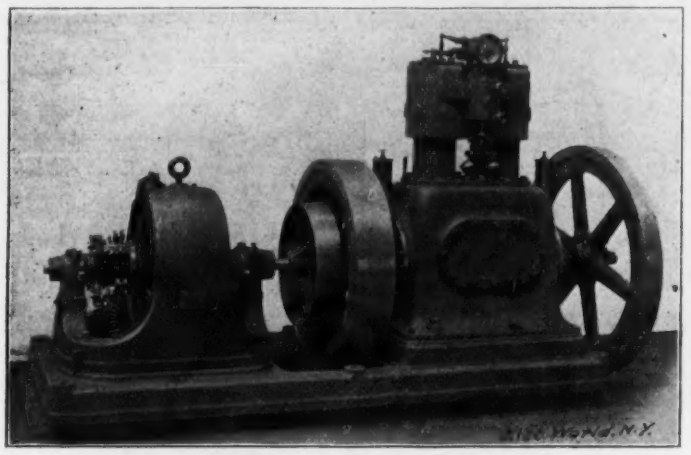


FIG. 4.—10-HP "KODAK" GAS ENGINE.

When the required pressure is obtained in the reservoir the belt is thrown off and the valve of the tank closed, thus insuring a supply of air for the next start. The air pump is supplied with a handle so that in case of accident to the air supply the tank can be recharged.

The lubrication of these engines is very similar to that of the Westinghouse steam engine, for the closed crank case carries a pool of oil which is splashed up to the pistons and other internal bearings by the lower ends of the connecting rods. The main bearings carry oil cups which serve to lubricate them and to keep up the supply in the crank case. The small cups and oil holes on the other bearings require but little oil, and are in plain sight.

The extensive experience of the company in steam engine construction has been particularly useful in the design of the gas engine. The bearings of the shaft and connecting rods are furnished with convenient means of taking up the unavoidable wear without affecting their alignment.

Altogether, the engines are uncommonly well constructed, and large numbers of them are being installed all over the country, using many varieties of fuel and doing all kinds of work. They are particularly well adapted for electric lighting and run as steadily as the best steam engines.

For the information contained in this article we are indebted to Mr. William P. Flint, an engineer of unquestioned ability, who has for several years past been a recognized authority on gas engines.

A Central Station Episode.

The manager of an electric light plant who has a duplicate set of machinery for generating the electric current that lights residences and streets, as well as the one that is struggling along "on the ragged edge," with his station taxed to its utmost limit, will appreciate the situation which confronted a manager in the capital city of Vermont.

There are two companies in Montpelier, and competition is very sharp; the new company having three 150-kw alternators driven by water power, with a load for only one, while the old company has two 100-kw alternators of modern construction, six arc dynamos and a job lot of ancient machines that a few years ago cost a large sum, but to-day are not salable. In this lot are three A 6 T.-H. self-exciting alternators and a 500-light Heisler dynamo. These four machines have been moved out to make room for the new alternators, but the old switchboard and station instruments are still in place, the circuits being connected to the new machines. Two engines and five water wheels, by the medium of a jackshaft and belts, supply power for the street and interior lighting.

This was the situation the day before the Legislature assembled for its biennial session of 1898. The men had been working night and day for two weeks, getting ready for the increased business, which included the lighting of the capitol. The material had been late in arriving, so that, at the last minute, a circuit was connected to one of the alternators without being protected by circuit breakers, but fuses were substituted for these and everything hitched up for a trial run; the next night business would commence in earnest. Everything went well, and a tired lot of men congratulated each other. But about 9 o'clock a wire fell across the new line, and the resulting short circuit failed to blow the fuses, but did wreck the armature, so that it could not be replaced without sending it to the factory. The three small alternators together had a sufficient capacity for the load of the disabled machine, but there was room to belt up only one of them, and each of the four circuits had a heavier load than any one of the machines could handle. A hasty calculation showed that by running about 2 miles of wire another circuit could be formed and the load divided up so that the small machines could carry it, provided they could be belted up. The manager was acquainted with the L. P. & D. system of belting, and he found room fo one dynamo between an engine and the jack shaft; then, by moving an arc dynamo, and making the belt a few feet longer, there was just room to squeeze in the third machine. A trip to the L. P. & D. shops showed that they had transmitters and split pulleys on hand of the size required. The foreman reported several miles of wire, not in use, that had formerly carried the Heisler current, but which had not been taken down, and his ability to take down the same, string it on the poles of the proposed line and make the necessary connections ready to start up the next night. The engineer said that he could move the machinery, set up and belt the transmitters and have his part ready, and the manager was to try his hand at wiring the machines to the old switchboard. About 4:30 the next afternoon, all the circuits were started up, not a customer being left out, the capitol lighted from dome to basement, and the Governor's reception, the event of the session, was a grand success.

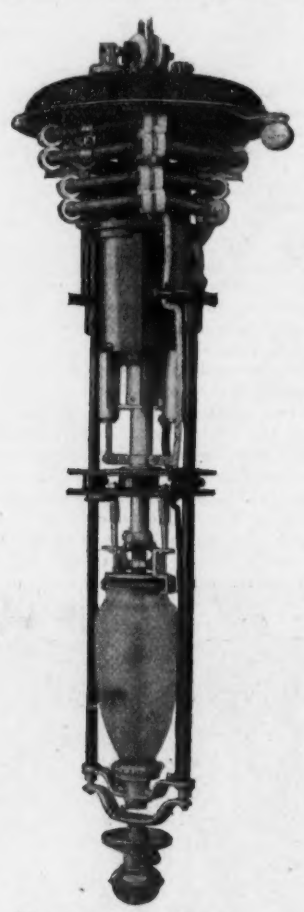
This remarkable performance was possible, first, on account of employees that had great courage and faith in "a long pull, a strong pull and a pull all together"; second, by using the L. P. & D. system, which makes it possible to run the driven and driving pulleys close together, utilizing space that would not be available with any other method of driving. In belting up the machines no lacings were used, but all belts were made endless, as the engineer is supplied with a kit of belting tools, and many a dollar is saved by repairing and building up belts that otherwise would be thrown away.

The electric lighting company is now engaged in developing a water power at Bolton Falls on the Winooski River, 17 miles below its present plant. The equipment will consist of two 450-kw General Electric direct-connected generators of the revolving field type, which will generate current at 12,000 volts. The line is to be of bare copper, and step-down transformers will be used at the station to adapt the current to the present lines.

A 220-Volt Enclosed Arc Lamp.

A perfected form of carbon-feed arc lamp for direct connection across 220-volt mains is being placed on the market by the General Electric Company. It operates with 120 volts at the arc, takes a normal current of 2.5 amperes and, with one trimming, has a life of from 130 to 150 hours. The light is of less volume and more violet in color than that of standard 110-volt lamps, but the

LAMP COMPLETE.



MECHANISM OF LAMP.

advantages of a 220-volt lamp, capable of independent operation, sometimes compensate for the diminution of light as compared with the General Electric 5-ampere power-circuit lamp for use two in series across 220-volt mains. A variable resistance at the top of the mechanism allows the use of the lamp on circuits of from 210 to 250 volts.

The 220-volt lamp is weatherproof, and may be used without a hood. It is especially suitable for lighting vestibules, doorways, window fronts, etc. It may be used with the closed outside globe or with the single globe and flared reflector. The casings are of several designs, the standard weatherproof casing being finished in black enamel.

A New Motor for Direct Connection.

The motor illustrated on the next page is built for direct connection to machine tools, printing presses, line or countershafts, etc., by the Triumph Electric Company, Cincinnati, Ohio. It embodies the Triumph standard construction throughout, and its design is exceptionally compact. Both armature and pole pieces are of laminated steel, the armature and commutator being

mounted on an independent spider, which is bored to fit the shaft of the tool to be driven. Ample room between spider and core is left for ventilation, and radial apertures are provided running from centre to circumference for the same purpose. It is stated that the temperature rise of one of these machines under ten hours' continuous run loaded was less than 10 degrees. Cast-iron perforated plates are fitted on each side of the frame, protecting both the fields and the armature.

The brushes are of carbon and are clamped positively in the holder, the construction of which is such that the tension can readily be adjusted. This type of holder is claimed to be superior to that of any depending on a sliding con-

Motor for Direct Connection.

tact between carbon and holder. The bearings are of bronze of the ring-oiling self-aligning type, and are carried on three-arm spiders attached to the frame, making an entirely self-contained and very compact machine. Oil wells of ample capacity are provided. The machine is built inverted, as a ceiling motor, and is made in six sizes, all based on 100 r. p. m.

Steam Separator and Oil Eliminator.

In designing this apparatus the object sought was to secure the highest possible efficiency with the least possible obstruction to the flow of the stream. To attain this result the interior of the separator was kept as smooth as possible, and all sharp corners and depending ledges avoided. These obstructions, it is asserted, not only add friction, but every angle from which the water of entrainment is sprayed by the current of steam will increase the saturation.

The cut in the next column shows the vertical and horizontal separators manufactured on these lines by the Hoppes Manufacturing Company, Springfield, Ohio. The steam inlet in both gradually enlarges into a chamber ten times the area of the pipe, and the outlet is gradually reduced to the original area. The principal feature of the separator is the interception of the entertainment by gutters which are kept partially filled with water. These gutters or channels, it is stated, have the effect of cutting off all the entrained water or oil, and are arranged to guard both the inlet and outlet. The entrainment caught by these gutters is carried to the bottom of the separator by small pipes.

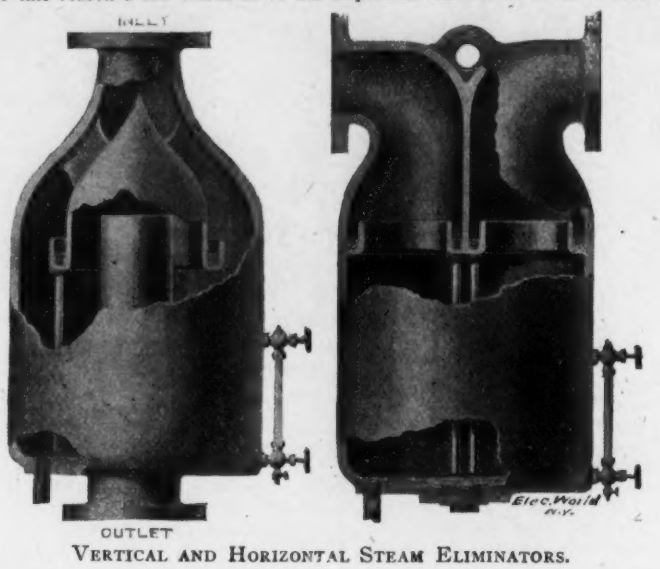
In the vertical separator the steam enters the top and all entrainment following the interior surface passes along that surface to the bottom of the separator and is intercepted by the water at the bottom. The water or oil in the steam which does not follow the surface strikes the exterior surface of the cone in the top, and is caught by the gutter and carried to the bottom by a pipe. In the horizontal type the steam may enter at either side, both sides being alike. All entrainment is caught by the gutters and carried to the bottom of the separator by the pipes shown, from which it is trapped off in the usual manner.

Both the vertical and horizontal separators are made in seventeen sizes, ranging in diameter of steam pipe from 1½ inches to 20 inches. For pipes 8 inches and over in diameter the separators are made from flange steel.

The I-T-E Rheostat.

The letters I-T-E, which have become so well known to the electrical trade in connection with the circuit breaker manufactured by the Cutter Electrical & Manufacturing Company, of Philadelphia, have been adopted in designating a new rheostat just brought out by the same concern.

In entering the field already occupied the company kept in mind the devices at present on the market, and remembered that only by producing a better instrument, at the same or lower in price, ultimate success could be attained. For this reason a few words as to the important features of the new rheostat will not be out of place. There are several points of design and construction which tend to render its breakdown impossible except through willful neglect. The design of the contact segments affords a large contact surface, and these segments are kept from turning on the base of the rheostat by means of small detents, which also prevent their working loose, as they are otherwise apt to do. The contact arm and the arm to which the handle is attached are in two separate independent pieces, so that the movement of the handle does not affect the pressure of the contact arm up the resistance segments. An entirely new feature is noted in that the arm and the base plate on which it is mounted can be removed by simply taking off a cap screw. This admits of the removal of parts for any adjustment which may be required.



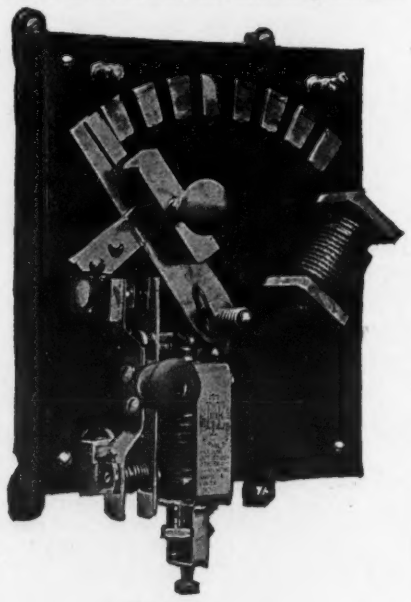
Vertical and Horizontal Steam Eliminators.

The tension of the spring holding the rheostat arm normally open is of sufficient strength to prevent it being left, either by accident or design, upon any segment excepting those which are not in circuit or those on the side of the rheostat where all the resistance is cut out.

The face is made of enameled slate, the advantages of which are obvious. The resistance is intended to meet the severe conditions of abuse, rather than the strain of ordinary use, and is attached to the back of the slate front. A chambered iron back is filled with a granular, vitreous, heat-absorbing material, which not only holds the resistance in proper position but absorbs and transmits whatever heat may be generated. By this construction an expansion of the resistance coils is allowed free movement in this heat-absorbing material. The resistance is so proportioned that 1½ times the full torque current flows the moment the motor is thrown into circuit, and the heating is so carefully distributed that the resistance itself can be hung in the air without any surrounding material whatever to absorb or radiate the heat, and not burn out.

Type A—I-T-E Rheostat.

Type B.



Type C.

Three types of instruments are now ready for delivery: Type "A," having a spring action only; type "B," having in addition to the spring action a no-load release, thus protecting the motor in case of interruption of circuit from any cause; and type "C," having in addition to the spring action and no-load release an overload function, which combines the essential features of an I-T-E circuit breaker, protecting the motor in case of interruption or of an overload.

A Direct-Reading Ohmmeter.

Those who have had experience in making electrical measurements and in testing with regular testing sets understand the importance and necessity of keeping the galvanometer away from extraneous magnetic influences. The operation is a delicate one under the most favorable circumstances.

There has been a demand for a reliable instrument for the direct measurement of resistance and free from the objections that are inseparable from the use of a galvanometer, particularly in places where there are stray magnetic fields—in a dynamo room, for instance. The direct-reading ohmmeter illustrated herewith is manufactured by the American Electric Specialty Company, 123 Liberty Street, New York, and is recommended as fulfilling every requirement in an instrument of this class, and as being free from the objections above noted as applying to galvanometer sets. This instrument is extremely

INSTRUMENT FOR THE MEASUREMENT OF RESISTANCES.

simple to operate, and has a wide range of measurement. Instead of a galvanometer a telephone receiver is used in the bridge.

A peculiar feature of the instrument is the stylus which is used for the purpose of varying the balancing resistance by touching at different points the wire stretched over the scale until a point is reached where no sound is given out by the telephone receiver. This point represents the balance of the unknown resistance against the known resistance, the value of which is indicated on the scale.

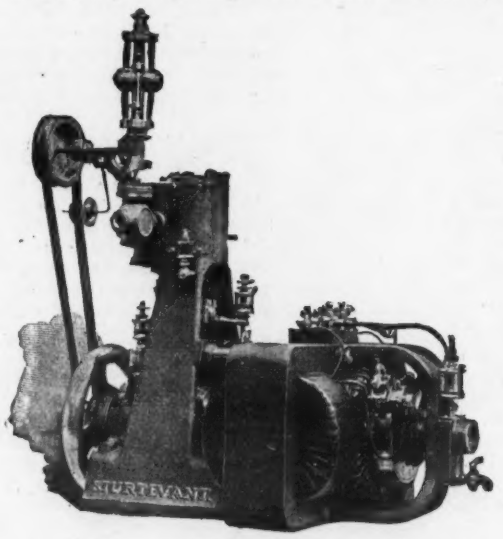
The rapidity with which a measurement can be made is one of the principal features of this instrument, and this merit, in addition to the many others which the instrument possesses, is one that will appeal to manufacturers and others who are required to make large numbers of measurements, such as the measuring of the resistance of incandescent lamps, testing telephone jacks, telegraphic apparatus, etc.

The instrument is compact and portable, and its dimensions are 17 inches long, 5 wide and 4½ high, and its weight is 7½ pounds. The battery, which is contained in the case, is guaranteed to last six months with continuous use and for several years with occasional use. The instrument needs no leveling, and its readings are unaffected by vibrations or stray magnetism.

A "Midget" Generating Set.

The "Midget" generating set, illustrated herewith, is claimed to be one of the smallest and most perfectly designed direct-connected machines ever constructed. The illustration was made from one of a number of sets recently built by the B. F. Sturtevant Company, of Boston, Mass., for the United States Navy, to be used in torpedo-boat service. The salient features of the design are reliability, low temperature, good regulation, ability to stand continuous overloads, minimum of attendance, high weight efficiency and great compactness.

This generating set was designed to be able to develop its rated output continuously with absolutely no sparking at the brushes and with a temperature



A TORPEDO BOAT GENERATING SET.

rise not to exceed 60 degrees Fah., while the total weight of the engine and dynamo complete ready for steam pipe was limited to 500 pounds for a rated capacity of 1.5 kilowatts. The speed adopted was 1000 r. p. m., and as the engine weighed 150 pounds complete, the weight of the dynamo could not exceed 350 pounds. In the finished design of the generator this weight was reduced to 250 pounds, of which 75 pounds was the weight of the armature complete, making the entire weight of the set only 400 pounds; that is, 100 pounds within the limit. This brought the weight efficiency of the output complete to 0.266 pound per watt output at rated capacity.

In order to insure steadiness in running as well as to economize in head room the centre of gravity was kept as low as possible by the adoption of the consequent pole type of magnetic circuit, giving a four-pole field with only two field coils, which coils being placed on the horizontal pole pieces reduce the height of the frame and consequent height of the shaft centre to a minimum, and at the same time render a sub-base unnecessary.

The field magnet consists of a wrought-iron forging to which are bolted the horizontal pole pieces. The armature is of exceptionally large diameter in order to facilitate ventilation and present as great a radiating surface as possible. The core discs are mounted on a brass spider having a flange support for the armature coils on the back end and an extended sleeve for support of commutator on the front. The ventilation of the core is facilitated by means of air ducts placed in the centre and at each of its ends. The air ducts consist of a series of radial vanes which, when rotated, act as a centrifugal blower. As the back end of the spider is completely closed and oil proof, all the air is drawn through the commutator, which is of skeleton construction.

The brush holders are of the reaction type, two only being used, as the armature is of the two-circuit, four-pole, barrel-wound type without cross connections. The brush yoke is supported by a projection from the out-board bearing.

The generator is compound wound for a constant e. m. f. (at constant speed) at all changes of load, from no load to 50 per cent. overload, and can stand this variation without sparking at commutators or any movement of brushes. It is stated that a continuous overload of 25 per cent. can be carried with safety.

The engine upon which the effectiveness of the combination depends is of special construction, designed to form a symmetrical part of the whole machine. Its single cylinder is 2-inch diameter by 2-inch stroke, all parts are provided with continuous oiling devices, the bearing surfaces are large and carefully finished, and every feature essential to sustained operation at 1000 r. p. m. has been introduced.

The "Straight Line" Iron Frame Bell.

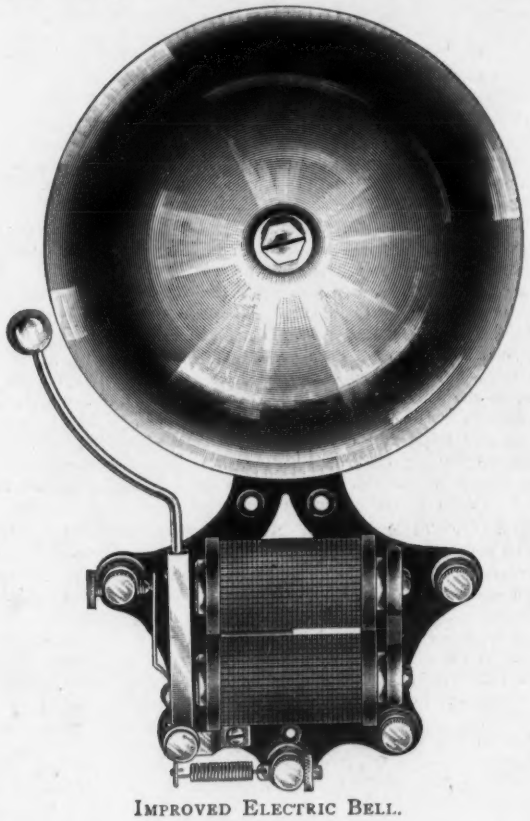
This bell possesses all the good features of the best bell on the market, such as cast bell-metal gong, platinum contact, etc., and, besides, it has been improved in design and construction.

The gong is cast with a square hole and forced on to a square standard and fastened in place by a heavy screw cap, which method of attachment prevents the gong from working loose.

The frame is so designed that it is unnecessary to remove the gong to install the bell, the screw holes being always exposed. The back of the frame is dished so that the frame bears on the edge, thus adapting itself to any slight irregularity on the wall; at the same time it cannot become loosened.

The magnet cores, instead of being screwed to the yoke, have a shoulder cut on them and are forced into a countersunk seat in the yoke. This gives a much better magnetic circuit than the old style and a stronger structure.

The armature is pivoted in adjustable brass-cone bearings, with steel trunnions, giving a wearing surface which lasts indefinitely without readjustment.



IMPROVED ELECTRIC BELL.

The contact spring is so attached to the armature that it cannot become loose, and it is possible to renew the platinum contact rivet without removing the bell from the wall. All the other parts of this bell, which is made by the Proctor-Raymond Manufacturing Company, 444 Niagara Street, Buffalo, N. Y., are brought to the same degree of perfection.

The full line of bells will consist of forty sizes, with ten movements, each movement being made by its own special tools, jigs, etc., the use of which enables the company to furnish the "Straight Line" bell at the same price now asked for much inferior bells.

NEWS OF THE WEEK

Financial Intelligence.

THE EDISON ELECTRIC ILLUMINATING COMPANY OF NEW YORK reports gross earnings during the month of October of $253,897.91, an increase of $39,317.31 over last year; net earnings, $100,800.10, an increase of $9409.45. For the ten months ending with October the gross earnings were $2,424,661.41, an increase of $466,326.29; net earnings, $1,009,185.85, an increase of $151,931.97.

Special Correspondence.

NEW YORK NOTES.

THE THIRD AVENUE RAILROAD COMPANY and the Metropolitan Street Railway Company on Tuesday of last week petitioned the municipal council and the board of aldermen for railroad extensions and connections. The simultaneous petitions are supposed to indicate that an amicable agreement exists between the two companies, and that there will be a division of the streets over which their tracks are to run which will be satisfactory to both. On the Boulevard, from Manhattan Street to One Hundred and Eighty-second Street, the cars of both companies are to run over the same tracks, but each company will have its own conduit. A public hearing will be held on December 22 on the petitions.

TO HOLD AN ELECTRICAL EXHIBITION NEXT YEAR.—The stockholders of the Electrical Exhibition Company, of this city, held their annual meeting on the evening of November 22. Among the business transacted was the unanimous decision to hold an electrical exhibition in this city in 1899. The exhibition during May this year at Madison Square Garden was successful in all respects, and no doubt next year's affair will surpass that of this year. The following named gentlemen were elected officers and directors of the company for the year: C. O. Baker, Jr., president; F. W. Roebling, vice-president; George F. Porter, secretary and treasurer; Marcus Nathan, general manager; H. H. Harrison, L. F. Requa, J. W. Godfrey and C. A. Lieb. It has not yet been decided when the exhibition shall be held.

THE AMERICAN GRAPHOPHONE COMPANY on the afternoon of November 23 gave, at its offices in the Bowling Green Building, a private demonstration of the latest development in the talking machine art to a few invited guests. The power of the new machine as compared with the modern standard phonograph is remarkable, and in most instances the reproductions were as clear and even louder than the originals. This was demonstrated by making records and reproducing them in the presence of the audience. The improvements embodied in the new machine mark a very distinct advance in the development of the art. Usually the evolution of apparatus and processes is by slow degrees, but in this instance a very long stride forward seems to have been made at one stroke.

THE APPOINTMENT OF TWO ELECTRICAL INSPECTORS.—Deputy Commissioner Walton, of the Department of Public Buildings, Lighting and Supplies for the Borough of Brooklyn, has increased the force of the Bureau of Electricity by the appointment of Messrs. Harry Byrne and Edward Sullivan as electrical inspectors. These two gentlemen were upon the eligible list certified to the commissioner by the Civil Service Commission, and the salary of each is at the rate of $1200 a year. Mr. Byrne is well known in the electrical fraternity, having been superintendent of installation in the Electricity Building at the World's Fair, and afterward electrical inspector in the Chicago City Electrical Bureau. For the past few years he has been prominently identified with important construction work in the East. Mr. Sullivan is also well known among electrical people, having been formerly superintendent of the Standard Underground Cable Company and previous to that electrician for the Brush Electric Company.

THE EFFECT OF THE HEAVY STORM ON THE ELECTRICAL SERVICE.—The severe snowstorm which visited the Atlantic coast on Saturday, November 26, and which was particularly violent in this city, found the various traction companies quite unprepared. The fall amounted to about 10 inches, a large part of which was wet snow, which packed tightly and afterward froze, and later became covered by fine dry snow blown by a swift gale into high drifts. The combination was more than the electric, cable, horse and steam railways could fight, and the elevated roads were the only ones that gave unbroken service. Fortunately the fall was on Saturday night, giving all day Sunday, with very light travel, for the clearing of the systems. The chief interest attaches to the working of the many miles of open-conduit electric lines in Manhattan Borough which have been put in service during the past year. This was their first severe test, and unfortunately they all went under. The whole system was practically shut down for twenty-four hours, from Saturday evening until Sunday evening, with stalled cars bunched in groups around the city, impeding all efforts to clear the tracks by sweepers and plows. The fault is not entirely that of the electrical conduit, as the Metropolitan Company, owing to the recent expansion of this system, has not provided itself with sufficient electrical plows and sweepers. The cleaning of the tracks had to be done mainly by horse power, and the heavy double-truck electric cars stalled along the lines greatly impeded the work. The cable roads came through much better, especially as the cable sweepers do not lose their tractive effort no matter how heavy the ice and snow, but pull right through with a force that no drift can resist. The heavy burden of snow also interfered with the electrical conditions of the underground conductors, especially at switches and crossings where salt was freely used. Salty snow and water pushed into the slot by the plows formed short circuits across their contacts and burned out many equipments, the dead cars being only a hindrance to those that followed. Such a storm, however, very rarely visits New York City, so that the experience is not likely to be repeated. With a sufficient battery of sweepers to keep the tracks free of snow as it falls such a general tie-up will probably never occur again. The electric conduit can, however, hardly be blamed, as the overhead trolley lines in the neighboring districts suffered just as badly.

AT THE MEETING of the American Institute of Electrical Engineers held on the evening of November 23 a paper by F. W. Carter, of London, England, entitled "The Design of Transformers," was read by Prof. W. S. Franklin, of Lehigh University, in the absence of the author. Mr. Carter's paper discussed the design of transformers solely from the point of view of minimum loss with one or another of several conditions, such as dimensions, etc., fixed. The discussion was entirely mathematical in character, and did not take into account the many circumstances of transformer design which cannot be expressed in formulæ, such as insulation, ease of rewinding, circulation of air and oil, etc. The discussion, owing to the difficulty of following the mathematical reasoning during the brief time devoted to the reading, degenerated into an argument as to whether scientific principles are or are not followed in practical transformer design. At the meeting of the executive committee of the Institute which was held in the afternoon the following named gentlemen were elected associate members: Cleveland Abbe, professor of meteorology, the weather bureau, Washington, D. C.; John Cassidy, superintendent Mutual Telephone Company, Honolulu, Hawaiian Islands, U. S. A.; James Francis Cosgrove, locomotive engineering department International Correspondence School, Scranton, Pa.; Donald Hume Fry, San Francisco, Cal.; James Hamilton, patent attorney, Boston, Mass.; Bernhard Hoffmann, New York Telephone Company, New York city; Harry D. James, draughtsman, Otis Brothers & Co., Yonkers, N. Y.; S. L. G. Knox, first assistant engineer, Crocker-Wheeler Electric Company, Ampere, N. J.; Howard Wallace Leitch, the Edison Electric Illuminating Company, Brooklyn, N. Y.; R. W. Lohmann, electrical engineer, Oakland, Cal.; C. Stowe Reno, electrical engineer, Triumph Electric Company, Cincinnati, Ohio; R. H. Sperling, assistant engineer, British Columbia Electric Railway Company, Ltd., Victoria, B. C.; James Wilkinson, chief engineer, Consolidated Electric Light Company, Birmingham, Ala.; A. Wilford Zahn, electrical engineer and superintendent, Manhattan Light, Heat & Power Company, St. Paul, Minn. The following named associate members were transferred to full membership: Franklin Robert Anson, secretary and manager, Salem Light & Traction Company, Salem, Ore.; Sidney Hand Browne, consulting electrical engineer, Baltimore, Md., and A. E. Brooke-Ridley, Siemens & Halske Electric Company, San Francisco, Cal. The committee on co-operative research, having completed the first stage of its work, has sent to various collegiate electrical engineering departments an explanatory circular, submitting twenty-seven subjects for their investigation.

NEW ENGLAND NOTES.

THE EDISON ELECTRIC ILLUMINATING COMPANY of Boston is distributing at the Exhibition of the Massachusetts Charitable Mechanic Association a neat little catalogue of its own exhibits. Every type of apparatus is listed and a little description given in each case. In the description of the heating apparatus, the cost per hour for the operation of heating utensils for a great variety of purposes is given. It is an interesting little catalogue and well gotten up.

VENTILATING THE BOSTON SUBWAY.—The thorough ventilation of the Boston Subway as well as the prevention of any possible moisture is receiving the careful attention that it deserves. A thorough circulation of air is necessary, and is to be secured by the operation of four special electric fans recently constructed and installed by the B. F. Sturtevant Company, of Boston. These are of the cone type, two of them 7 feet in diameter and two 8 feet in diameter. Each is driven by a special Sturtevant direct-connected motor, and operating together they have a capacity equivalent to changing the air in that portion of the subway with which they connect once in fifteen minutes.

THANKSGIVING GREETING FROM PROVIDENCE.—The American Electrical Works, Providence, R. I., never forgets its friends on holiday occasions. Their Thanksgiving greeting this year consists of a card in three folds, the central one of which contains a few thoughts appropriate to the occasion, and on the two end folds are illustrations of the ingredients of a Thanksgiving dinner. The whole idea has a "point," but the point is hidden in a little wooden tube which contains a needle and thread to sew up the turkey. The needle and thread are real, and the needle point is real, but, alas, the turkey is not quite so substantial. Indeed, it is no turkey at all, but only a picture of one. However, the deficiency in this respect is offset by the warmth of the company's good wishes.

PHILADELPHIA NOTES.

LIGHTNING AND LIGHTNING ARRESTERS.—Mr. Alexander J. Wurts, of the Westinghouse Electric Company, of Pittsburg, Pa., read a paper on the evening of November 22 before the electrical section of the Franklin Institute, on "Lightning and Lightning Arresters." Mr. Wurts said in substance: In earlier days, when people were more superstitious than now, fires were lighted and bells tolled to drive away the dreaded lightning; but when Benjamin Franklin established the identity between lightning and electricity,

people were glad to accept the results of his experiments and adopt so reasonable a device as a lightning rod. The lightning rod was a reasonable device at that time, because the public mind was ripe for it, and Franklin had shown that not only would the rod prove a good conductor, but that points on its upper terminals would in certain circumstances prevent the lightning discharge. (Experiments were then shown illustrating these principles.) But now, after 100 years' experience, and with statistics before us, this means of protection has lost much in popularity. Aside from public buildings and houses of the less intelligent class of people, the rod is rarely seen. Statistics show that in nine years, ending 1895, in the United States, there were 4175 fires, with a loss of $14,000,000. During ten years, ending 1893, there were 2679 barns, 129 churches and 831 dwellings struck by lightning, less than 100 dwellings a year out of the millions in this country. During five years, ending 1894, there was a maximum loss of 336 lives. These figures are certainly not alarming, but do seem to warrant in general the use of the lightning rod. Nevertheless, the speaker recommended this device for costly and prominent buildings, for tall monuments, church spires, brick chimneys, etc., especially in rural districts. Experiments were then shown to illustrate how the lightning stroke gathered into a bolt. It was also shown that the kind of metal of which the rod is constructed is of small importance. Globular lightning was thought to be a fact, and a letter from an eye-witness was read. Some interesting experiments were then shown, illustrating the damage done to electrical apparatus during the thunderstorms. Various devices designed for the protection of dynamos and motors were displayed on the table. In conclusion Mr. Wurts stated that although much has been learned in recent years about lightning and atmospheric electricity, nevertheless there are still mysteries to be solved in this fascinating field of natural science.

BUFFALO AND NIAGARA FALLS NOTES.

THE NIAGARA POWER COMPANY has closed a contract with the Electric Lead Reduction Company, which makes use of an electro-chemical process in its manufactures and will take quite an amount of power. It will occupy the building of the Chemical Construction Company near the power house.

IT IS ANNOUNCED that James Morton, of the firm of Alexander Morton & Co., carpet manufacturers, of Scotland, is at Niagara Falls negotiating for electric power with which to run a large factory which is to be a branch of the home concern. An arrangement has already been made, but the particulars have not yet been made public.

AN EFFORT is being made to consolidate the Ely and Smith trolley lines from Buffalo northward. This will, if accomplished, practically reduce the four competing lines to Tonawanda to one, as the north line has been abandoned and the Kenmore line now belongs to the Ely Company. It was folly to undertake so many roads, for they soon fell to cutting rates and carried passengers for a nickel, at which none of the roads could pay expenses.

THE UNION CARBIDE COMPANY has closed a contract with the Niagara Falls Power Company for 15,000 additional electrical horse-power to be delivered during the next summer. In order to utilize this large amount of power new works on an extensive scale will be constructed at once. The existing works of the Carbide Company will be continued. The new buildings will be located on the power company's land, and one of them will be two stories high and over 800 feet long.

THERE IS some disappointment felt in Buffalo on account of the slow development of demand for Niagara power, and there are capitalists there who claim that the power company does not care to sell much current in Buffalo, preferring to concentrate everything near its works, where it has land in quantity to sell. There may be a grain of truth in this, but at the same time it appears to have been the aim of the company to accommodate all comers, here or there. It may prefer to capture new concerns on its own territory, but an electrical engineer is doubtless right when he says that the company never built a line to Buffalo costing half a million or so, just for a bluff. Business will come in time.

CHICAGO NOTE.

"THE ELECTRIC MOTOR-VEHICLE" was the title of a paper read before the Chicago Electrical Association on November 18, by Mr. C. E. Woods. The speaker took a very enthusiastic view as to the future of electric vehicles, based upon the following facts: Sanitary conditions attending their use; lesser cost of maintenance as compared with horses; rapidity of movement; less space occupied in streets and stables, and freedom from expense when not in use, all of which entirely offsets the objections which first appear as to greater initial cost. He traced the development of the modern electric vehicle, and cited his own experience in this line of work. Three years ago he thought it would never be possible to build one with any mileage capacity at all at a less weight than 1800 or 2000 pounds, yet to-day he has vehicles in operation which weigh 800 pounds, including everything, having a mileage capacity of about 28 miles on one charge of the batteries. This vehicle is equipped with one 2½-hp motor, thirty-six cells of sixteen ampere-hours capacity for two hours, which run the vehicle at a speed of 14 miles an hour, carrying two persons. The batteries weigh 440 pounds, the balance being in the motor and vehicle. He builds equipments of four classes, viz., for two persons; for a top carriage or a heavy buggy; for a trap or brake for four passengers, and for commercial delivery wagons and heavy cabs. These range in weight, complete, from 800 pounds to 2400 pounds. In the first equipment thirty-six cells of battery are used, and in the other three forty cells each. Mr. Woods then gave a condensed compilation of the tests made with one of his large cabs. For this vehicle he designed two motors of 3½ nominal horse-power, each of which was capable of running the vehicle at a slight overload under normal conditions of roadway. The tests of the cab on a macadam and asphalt road showed very little difference, and at a speed of 12 miles an hour took 45 amperes at 72 volts at the motor terminals. The vehicle has a total load capacity of 3200 pounds, including the weight of four persons, and it carries forty cells of battery. He called attention to the very great difference in the amount of power consumed in the use of rubber tires. He tried a new tire on the cab and it consumed 18 per cent. more power than the ones he had been regularly using. He has determined by careful tests that the hard-rubber tire is far preferable to the pneumatic tire for use on electric vehicles, without any reference to first cost, durability or freedom from puncture. The pneumatic tire absorbs more energy by about 20 per cent. when inflated, and by a very considerable increase when it becomes deflated to different points of pressure. He has adopted exclusively the series paralleling of the batteries, and has found three speeds to be sufficient for practical purposes. The matter of allowable speeds was also touched upon, and he considered that 14 miles an hour was about the practical limit for large vehicles, although he has run a light road buggy at a speed of 20 miles an hour with a load of 800 pounds. The vehicle could be handled with a reasonable degree of safety on boulevards and parks. He expressed the hope that those directly interested in the development of the storage battery for motor-vehicle work will impart some information regarding the difficulties they have had to overcome. In his own experience he has found that the storage battery has more than met his expectations, both in capacity, weight and durability, and with such improvements as may be made from this time on there need be no further anxiety regarding the success of the storage battery in such work.

ST. LOUIS NOTES.

THE CENTRAL UNION LONG-DISTANCE TELEPHONE COMPANY has completed its line from Centralia, Ill., to Ashley, Ill., giving Centralia, Richview and Ashley direct communication with St. Louis.

THE ST. LOUIS COUNTY STREET RAILROAD.—The County Court is considering a proposition of the St. Louis County Street Railroad to convert its motive power from horse-power to electric. The court is also considering the right of the company to build west of the Wabash tracks. Preparations are being made to begin work at once on the construction of a double track from the city limits.

THE FIRE ALARM DEPARTMENT continues to have trouble with corporations which have placed their wires underground. George A. Warrance, superintendent of construction for the Missouri Edison Electric Company, was arrested a few days ago on a charge of interfering with the fire-alarm system. He was complying with the ordinance requiring the removal of poles.

PACIFIC COAST NOTES.

MR. W. S. HEGER, of San Francisco, the Pacific Coast district agent of the Westinghouse Electric & Manufacturing Company, recently visited Pittsburg, Pa., and other Eastern cities.

THE MARKET STREET RAILWAY COMPANY, San Francisco, will extend its Folsom Street electric line from its present terminus along the San Bruno road to the Five-Mile House. The company is welding its rail joints on Kearny Street, using the Falk system.

MR. HENRY H. BECK, who was for eleven years manager of the American District Telegraph Company in this city, died in Oakland, on November 13, after an operation for an intestinal trouble. He was a native of Bohemia, Austria. About two months ago he resigned his position to become president and superintendent of the Oakland Burglar & Fire Alarm Company. He leaves a widow and a son.

THE MUTUAL ELECTRIC LIGHT COMPANY, San Francisco, will probably be authorized to erect overhead wires in accordance with a recent decision by Judge Seawell. The decision is in a suit brought by the Mutual Company against the mayor and the board of supervisors. It holds, substantially, that as long as the San Francisco Gas & Electric Company is permitted to maintain posts and poles for the stringing of overhead wires it is the legal duty of the supervisiors to grant the rival corporation a similar privilege.

CANADIAN NOTES.

THE WILSON CARBIDE COMPANY, of St. Catharines, Ont., states that calcium carbide has gone up 30 cents per cwt., and that the demand for it is so great that it is impossible to buy it in quantities of more than 500 pounds.

MR. C. J. BALLANTYNE, of Honolulu, formerly a resident of Ottawa, is now in that city. Recently he organized a company, and bought the franchise to operate an electric railway in Honolulu. He is now on a visit to the leading American and Canadian cities with the object of purchasing a plant, and also studying the systems upon which electric roads are operated.

THE LUNENBURG GAS COMPANY, of Lunenburg, Nova Scotia, is changing its electric plant from steam to water power. It has a 16-foot dam nearly completed on the Mush-Mush River at Mahone, 8 miles from Lunenburg. The water wheel is from the works of the S. Morgan Smith Company, York, Pa., and is one of its "New Success" turbines. The company will light the town of Mahone, in addition to supplying light and power to Lunenburg.

ON NOVEMBER 18 the shareholders of the Royal Electric Company, of Montreal, met to consider the proposal of the directors to increase the capital stock of the company, which stock is now $1,500,000, by the issuance of 2500 shares for the nominal value of $100 each, to be offered to shareholders; and also to effect loans by the issuance of mortgage or hypothecary bonds or debentures to an amount not exceeding in the aggregate 75 per cent. of the paid up capital stock. The proposal, however, did not meet with the favor of the shareholders, and it was voted down by a majority of 932 shares.

THE METROPOLITAN ELECTRIC COMPANY will be supplying electric light, power and heat to the city of Ottawa probably by the end of March next. The survey of the company's water power at the Britannia Rapids, about ten miles from Ottawa, has been completed, and everything is now ready for

the work of constructing the power-house and arranging for the transmission of electricity. Tenders have been called for, and about the 1st of December operations will be started. The Metropolitan company has two lines under construction for the transmission of the electric power. Only one of these, however, will be operated at present. Through a point of land on the Ontario shore of the Ottawa River which juts out into the Britannia Rapids a canal of about 125 yards long and 20 feet wide will be made. At the foot of this canal will be built the power-house, and the water from the rapids will be concentrated in the canal.

THE ONTARIO GOVERNMENT will probably ask the courts to determine whether or not the Niagara Power Company has forfeited the charter which it obtained from the provincial authorities. The agreement between the Government and the company called for the development of 10,000 horse-power by the first of November last, and 25,000 horse-power at a later period. The Government takes the view that the company has not fulfilled the first of these conditions, and that it has therefore no further right to the charter. The company on the other hand points out that under another section of the agreement the charter was only to be forfeited in the event of a failure to transmit electricity. It claims that it has been impossible to comply with the latter condition, as up to a very recent period the problem of long-distance transmission had not been solved. Furthermore, the company says it cannot fulfill the contract to supply electrical energy, because there is no demand for it.

French Notes.

ELECTRIC CABS IN PARIS.—The Compagnie Générale des Voitures has placed twenty electric cabs on the streets of Paris. To this contingent should be added Cab No. 16,000, belonging to the Compagnie des Transports Automobiles, which has been on the streets for some time, taking fares at usual rates.

ELECTRICITY IN THE DEPARTMENT DE L'AIN.—The townships of Dortan, Arbent and Marchon and the canton of Oyonnax will shortly have an electric light and power service. The energy will be furnished by the River Ain. The works are already under way near Condes, a few miles from Dortan, above the junction of the Bienne with the Ain. The power developed will be very large, the figure running up into thousands of horse-power. The dam, which is the largest part of the work, is nearly done. Overhead lines will be used to transmit the current to the towns, where it will be transformed and distributed for light and power. The industries of these towns will be greatly benefited. The Falls of the Ain will supply energy to a number of other places besides those mentioned, notably to Saint-Claude.

MEETING OF THE NATIONAL SOCIETY OF ELECTRICIANS.—The regular meeting of the National Society of Electricians was held on November 9, with President M. R. V. Picou in the chair. The first subject presented was that of charging for electrical energy, M. Pellissier calling attention to the fact that profits may be increased by reduced rates owing to the increased load obtainable and consequent reduced cost per kw-hour, which may be greater than the reduction in the tariff. After a discussion of day loads, motor rates, etc., he described the Wright demand system. M. de Marchena followed with a description of the new electric traction system installed by the French Thomson-Houston Company in Paris between Aubervilliers, Pantin and la Place de la République. This is supplied with the overhead trolley outside the city limits and accumulators on the urban lines. Each car carries a battery of 224 cells, with a capacity of 35-ampere hours, made by la Société Pour la Travail Electrique des Métiers. The cars have seats for fifty-six passengers, twenty-eight outside and twenty-eight inside. The generating station at Aubervilliers contains three Roser boilers of 300 horse-power each, three horizontal Corliss-type engines of 250 horse-power each and three compound-wound, six-pole, 150-kw Thomson-Houston dynamos, arranged to give 575 volts for charging the accumulators in the station. At the end of the meeting M. Maurice Le Blanc described a new method of compounding alternating dynamos for constant potential.

THE ELECTRIC LIGHTING OF THE CHAMBER OF DEPUTIES.—The electric light plant installed in the Palais Bourbon for lighting the Chamber of Deputies and the Presidential Mansion is chiefly notable for its use of gas engines. These machines were used to avoid building a high chimney and also the escape of smoke and the introduction of a large amount of coal into the palace. There are two gas engines of 30 horse-power running at 150 r. p. m., and four engines of 50 horse-power running at 165 r. p. m. The present capacity of 260 horse-power is sufficient only for present needs, and it is expected that the capacity will be increased by the substitution of 50-hp engines for the 30-hp machines, and by the addition of two 60-hp engines with this capacity of 400 horse-power and a large battery. The plant will take care of the lighting of the whole Palais Bourbon. The engines are started electrically, being too large to be started by hand. Water tanks located in the corners of the room are of sufficient capacity to keep the plant running one day. The battery has 64 Tudor cells, of thirteen positive and fourteen negative plates each. Its present capacity is 1250 ampere hours for a five-hour discharge, and with the extension of the plant it is expected to reach a capacity of 1800 ampere hours. These extensions will without doubt be put in soon, as the Chamber of Deputies has voted the funds for the building of a new deliberating hall, the electrical illumination of which will be much more extensive than that of the present hall. It is estimated from the present needs that it will be necessary to provide 4610 lamps varying from five to 100 candle power, apportioned as follows: 1440 lamps for use in the parliamentary rooms, 2640 for the Presidential Mansion and the grand gala hall and 530 lamps for miscellaneous rooms.

COMPETITION IN LYONS.—Hitherto there have been but two competing companies in the electric light business at Lyons; they are the Gas Company and the Jouage Canal Company. A third has appeared on the scene, and it is the Omnibus & Tramway Company of Lyons, working behind the recently incorporated Lyons Electric Power Company. This company asks the right to take the surplus power of the street railway company and conduct it by underground conduit to stations, where it can be stored. At these stations it is to be put on bus bars at the proper voltage for use in lighting, and will be distributed by underground conduits to customers. The necessary apparatus is subject to patents owned by the company. The Gas Company objected on the ground that the Electric Power Company intended to tap the overhead wires, and it memorialized the city government on this subject. The Electric Power Company, however, agreed not to do this, for the present at least, confining its taps to the underground system. The Municipal Council, believing that no one could possibly find any grounds for legitimate objection to tapping the underground conduits, granted the desired permission with the following conditions: 1. All taps must be made from the underground feeders where such exist. 2. No tap will be allowed from the trolley without special permission for each case, obtained from the City Council. It would seem, then, that a railway franchise may carry with it the right to furnish light and power if the sole right to do this has not already been granted. In consequence Lyons is full of railway promoters; but it will not always be possible to utilize the surplus power easily. Customers will not always be found on the line of the railway. First, the excess of power must be available, and next, a special permission must be obtained to sell it. The cost is also a factor, if the current has got to be stored and transformed in the manner in which the Lyons Electric Power Company proposes to go about it. It is true that the company expects to obtain special permission to supply power directly from the trolley in the suburban districts. Another trouble which will come up is the low price which the inhabitants of Lyons will be able to force on the supply of current owing to the presence of three competitors. The Jouage Canal Company may be expected to reason as follows: "My chief profit comes from the supply of power; I can afford to sell light cheap." The Street Railway Company will say: "My profits are made in my cars; I can afford to sell light cheap." And the Gas Company also has good reason to say to itself that it is the new improvements which have been introduced in the utilization of gas which will show the greatest margin of profit, especially considering the almost daily increase in the use of gas for heating and power. The Electric Power Company has already offered to furnish lighting at a maximum price of 16 cents per kilowatt, accompanied by a sliding scale to reduce the price, according to the amount consumed. To the municipality a price of 12 cents per kilowatt hour has been made.

A SWISS INSPECTION BUREAU FOR ELECTRIC CENTRAL STATIONS.—The Swiss Society of Electricians has organized an inspection bureau for central stations, which provides a useful and effective service. It is to be hoped that other countries will soon be supplied with similar institutions. The traiff, which seems reasonable, is arranged as follows: (A) For central stations which sell current (these stations must be members of the Swiss Society of Electricians); yearly dues, 1½ per cent. of the capital chargeable to the electrical portion of the installation, accumulators being put in at one-fifth of their cost; minimum charge, $20; maximum, $300. (B) For central and isolated plants generating current for their own consumption only: (a) generating stations with switchboards and interior wiring. For a single machine the charge is $2 per year. For each additional machine $1; (b), motor stations with switchboard and interior wiring. For a single machine the charge is $2 per year. Motors rated at less than 1 horse-power are charged for as lamps on a basis of ten lamps per horse-power; (c) for incandescent lamps and wiring; the charges are as follows:

Lamps Connected.	Yearly Cost of Inspection.	Lamps Connected.	Yearly Cost of Inspection.
50 or less	$3.00	701 to 800	$17.00
51 to 75	4.00	801 to 900	18.50
76 to 100	5.00	901 to 1000	20.00
101 to 150	6.00	1001 to 1100	21.00
151 to 200	7.50	1101 to 1200	22.00
201 to 300	9.00	1201 to 1300	23.00
301 to 400	11.00	1301 to 1400	24.00
401 to 500	12.50	1401 to 1600	25.00
501 to 600	14.00	1601 to 1800	26.00
601 to 700	15.50	1801 to 2000	27.00

No distinction is made for difference in candle power of lamps. One arc lamp is rated equal to ten incandescents; (d) transformer stations, with switchboards and interior wiring. The yearly charge is $2 for each station; (e) underground and overhead distributing systems: Overhead lines, for the first 2 kilometres the charge is $4 per year per kilometre. Additional lines are $2 per year per kilometre. Underground wires are $2 per year per kilometre. (f) accumulators: Batteries up to 50 kilowatts at $2 per year; batteries of 100 kilowatts or above, $6 per year. Notes.—The classes under (b), (c) and (d) include all wiring within 100 metres of the generator. Both tariffs apply throughout Switzerland. Tariff A includes traveling expenses, tariff B applies only to such stations as can be reached by railway lines giving reduction on mileage. If it becomes necessary to travel over other roads or to go by boat, stage or special conveyance, the extra expense is charged up.

ELECTRIC CRANES FOR THE EXPOSITION OF 1900.—French manufacturers have been invited to submit proposals for the erection and operation of two electric traveling cranes for use in the Hall of Motive Machinery at the Exposition of 1900. The transmission of energy by electricity will receive a very interesting application in these machines, which are to play a very important part in the location and erection of the machinery to be exhibited at the Exposition. The details of the competition were drawn up by M. Gugenet, chief engineer in charge of maintenance and erection apparatus, and presented by Delaunay-Belleville, director-general of operation, to M. Alfred Picard, commissioner-general, who approved it. The requirements include the construction, erection, operation and the final removal of the cranes and their supports and ways. The apparatus, which is installed, will be entered in the catalogue and passed upon by the international jury, and will therefore be in competition for prizes. The capacity of these machines will be 25 tons each, with a span of 87½ feet, and a height above the ground of 48½ feet. The travel will be 450 feet, and the machines must be capable of operating at the following rates for slow speed and double these rates for high speed: Rate of lifting, 4½ feet per minute; rate of travel of the carriage, 35 feet per minute; rate of travel of the whole machine, 58 feet per minute. The whole structure is to be composed of sheet metal rods and angle irons, all of steel, and must be built so that no part of the structure will re-

ceive a strain exceeding 14,000 pounds per square inch. The motive power will be electricity, supplied in such a way that the conductors will be out of reach of the general public. The question of location of the motor, whether it is to be stationary and at the end of the travel or mounted on the crane itself, is optional with each designer. The crane is to be supported on eight-wheeled trucks, running on double rails laid on oak sleepers. The rails will be held together by rods sufficiently numerous to form practically a toothed rack, upon which will act cog-wheels which move the crane. Friction clutches will be used wherever possible to avoid sudden shocks. The proposal sets forth all the conditions of the competition. The machines must be built and set up in their shops within six months, painted and transported to the exposition grounds within seven months, erected and ready for testing within nine months. They will have to stand a test under a load of 30 tons. Special requests of the competitors and their guarantees and the lists of similar machines erected by them will be examined by a commission presided over by the director-general of operation, and composed of the financial director of the exposition, the secretary-general and the chief engineer of maintenance and erecting machinery. The designs selected by these men will be examined and classified by a jury whose chairman will be the director-general of operation, and on which will serve the chiefs of the architectural department, the chief engineer of maintenance and erecting machinery, the engineer in charge of all metal constructions, the engineer in charge of the mechanical and electrical exhibits, the president of the technical committee on machines, with the president of the third sub-division of this committee, and finally the president, vice-president and secretary of the committee on the admission of Class 21 (general mechanical apparatus). Manufacturers who wish to enter this competition must send written notice of their intentions to the general commissioner of the Exposition of 1900. The two successful cranes will be ready for use by exhibitors by October 1, 1899, and will remain in service until February 1, 1901. It seems unlikely that the public will be allowed to ride on these machines. Nevertheless, it should be remembered that at the Exposition of 1839 two similar electric traveling cranes in Machinery Hall were very successful as exhibits. It is true that they were somewhat differently arranged from those which will be used in 1900. They spanned 70 feet and traveled a distance of nearly 1600 feet on rails, carrying 150 passengers at each trip. The carrying of passengers was, of course, simply an afterthought, the object of their existence being to facilitate the setting up and removal of the mechanical exhibits.

General News.

THE TELEGRAPH AND TELEPHONE.

LONDON, ONT.—The People's Telephone Company, according to reports, intends to install a plant here at once.

DALLAS, TEX.—The new long-distance telephone service between Dallas, Memphis, New York, Chicago and St. Louis will, it is expected, be inaugurated early in December.

KANSAS CITY, MO.—The recent blizzard wrought considerable damage to telephone and telegraph wires in this city and surrounding towns. Street railway traffic was also interfered with.

SPENCER, IA.—The Citizens' Telephone Company, of Spencer, has filed articles of incorporation. The capital is $10,000. The incorporators and directors are: O. E. Sully, William Flindt, Ackley Hubbard, C. J. Mikish and J. F. Green.

LANSING, MICH.—As the result of the refusal of the Bell Telephone Company to use poles jointly with the Lansing Telephone Company, every Bell telephone has been removed from the city offices and departments by order of the common council.

PASSAIC, N. J.—The New York & New Jersey Telephone Company is making plans to erect a building in this city for its own use. The exchange will be a modern fireproof structure of stone and two or three stories high, and will be similar to those in Elizabeth and Morristown.

COLUMBUS, OHIO.—The Interstate Telephone Company, of Cleveland, has been incorporated by J. A. Rutherford, Scott R. Hayes, C. B. Arthur, R. M. Fuller, and O. C. Evans. The company proposes to construct and operate a line from Cleveland to Cincinnati, with branches. The capital stock is $25,000.

BOSTON, MASS.—It is stated that it is proposed to reorganize the companies in the Western Electric Telephone system by combining them in one company, with a capital stock of $500,000. Companies owning nearly 4000 miles of toll lines have virtually consented to come into the new arrangement. These companies, it is stated, all use the Bell instruments, and have contracts with the Northwestern Exchange Telephone Company and the Iowa Telephone Company.

BOSTON, MASS.—The Erie Telegraph & Telephone Company has recently introduced in Texas a new class of service that is known as the "one way five-party service." That is, one may have a telephone in his residence from which he can communicate with all the subscribers connected with the exchange at the rate of $12 per annum, but no one is allowed to call this subscriber, and his name is not listed on the books. This same class of service is furnished for business purposes at $15 per annum.

ALBANY, N. Y.—The New Rochelle & Westchester Telephone Company has been incorporated here to operate in New York, Massachusetts, Connecticut and Rhode Island. The capital stock of the company is $150,000, and the directors are Heinrich Mayer, New York; H. A. Connor and F. H. Kellog, Brooklyn, and others. It is stated to be the purpose of this company to establish exchanges in the smaller cities and eventually to connect different cities. For the present the business will be confined to a system between New Rochelle and Mamaroneck. It is stated that the company will use the Phœnix electric telephone appliances.

NORFOLK, VA.—The Southern States Telephone Company has just completed a modern private telephone system for the Norfolk & Portsmouth Belt Line Railroad. In addition to the telephones a switchboard has been installed in the superintendent's office, which enables the connection of any station on the belt line with any line of the Southern States Telephone Company. A telephone has also been installed in the keeper's tower on the drawbridge. The wires are so arranged that the opening of the draw does not interfere with the service. Superintendent Pannill and his assistants, Messrs. Cole and Miller, designed and installed this plant.

NEW BEDFORD, MASS.—The Automatic Telephone Company, which was recently organized here, will, as soon as 500 subscribers have been obtained, begin the construction of a first-class underground telephone system, with a private metallic circuit and long-distance instruments for each subscriber. It is stated that 400 subscribers have already been obtained. The company has a capital stock of $100,000, and its incorporators are prominent business men of New Bedford. The officers and directors of the company are: President, John W. Macomber; vice-president, F. T. Akin; treasurer, Frederick Taber; clerk, Arthur E. Perry. Directors, the above-named gentlemen and B. F. Brownell, Lot B. Bates, Frank R. Kirby, Joseph Poisson and J. L. Gillingham.

NEWARK, N. J.—During the past year or two great improvements have been made in apparatus for central telephone exchange offices. The Newark Telephone Company, of Newark, N. J., has just installed a new central office equipment that is said to possess novel features of an extraordinary nature never before introduced in a central office exchange. It does its work so rapidly that a great deal of time and money is saved, requiring fewer operators and at the same time giving better service. The Newark Telephone Company is an opposition to the Bell, and the success of this exchange equipment is said to be highly successful. This exchange is connected directly with 2100 local subscribers, and also has connections with sub-stations, giving it a total of over 3100 connections.

ELECTRIC LIGHT AND POWER.

INGERSOLL, ONT.—The Town Council has appointed a committee to negotiate the purchase of the waterworks and electric light plant.

LINCOLN, ILL.—The receiver of the Lincoln Water, Light & Power Company has placed an order for a 120-kw alternator with the Royal Electric Company, of Peoria, Ill.

LANCASTER, PA.—The Lancaster Light, Heat & Power Company has executed a mortgage for $100,000, the proceeds to be applied to increasing the capacity of the plant.

ELWOOD, PA.—A special election will be held on December 20 to secure the consent of voters for an issue of bonds in the sum of $8000 for the purpose of building an electric light plant.

PITTSBURG, PA.—Mr. G. H. Winslow, a consulting electrical engineer of this city, is preparing plans and specifications for an electric light plant for a manufacturing company in this vicinity.

HAMILTON, ONT.—Mr. Percy Domville has been instructed by the special electric light committee to prepare an estimate for an electric lighting plant of 300 arc and 3000 incandescent lights capacity.

HAZLEHURST, MISS.—The material has arrived for the electric light plant, but as there exists some misunderstanding between the city and the electric light company, further proceedings have been postponed for the present.

AVOCA, PA.—The Standard Electric Light, Heat & Power Company of this place has been reorganized, and extensive improvements have been made in the arc and incandescent services. Mr. Howard, late electrician for the Weston Engine Company, Painted Post, N. Y., has been appointed superintendent.

DURING THE QUARTER ended March 31 last the value of carbons exported from Vienna for the United States was $5,924, and similar goods to the value of $10,115 were exported to the United States from Nuremberg, Germany, during the same period. From Rheims, France, came "electric machinery" to the value of $51.43, and from St. Catharines, Ont., calcium carbide valued at $1764 was brought into the country.

PHILADELPHIA, PA.—It is stated that a deal is being engineered in this city having for its object the consolidation of the three electric light plants in Baltimore, namely, the Brush, Edison and Northern companies. It is stated that a banking house has secured options on the bonds and stocks of the Baltimore companies. The three concerns are capitalized jointly at $2,899,000, and their total issue of bonds amounts to $1,874,000. The plan is to deposit these securities in trust as security for an issue of $4,000,000 5 per cent. thirty-year collateral trust and mortgage bonds of the consolidated company, to be additionally secured by a mortgage on all the property and plants.

BATESVILLE, MISS.—An electric light plant is to be established in this place, the Hon. L. L. Pearson, through his agent, Mr. D. L. Rush, having contracted with R. S. Stearn, of New Orleans, agent for the Fort Wayne Electric Corporation, for all the necessary equipment for 300 lights. The plant is to be in operation within sixty days. It will consist of one 660-light Fort Wayne alternator, with all the necessary station instruments; Fort Wayne transformers, one 65-hp high-speed automatic engine and two 40-hp boilers. Mr. Pearson will equip his new opera house with a number of modern electrical appliances, and will light it with 100 16-cp lamps, or their equivalent. Mr. D. L. Rush will superintend the construction of the plant. White cedar poles will be used throughout, and everything will be first-class and up to date.

THE ELECTRIC RAILWAY.

OMAHA, NEB.—An anti-car-crowding society is the latest organization in Omaha. The society is the outgrowth of long suffering from crowded cars. The organization was effected at a mass-meeting a few days ago.

BRIDGETOWN, ONT.—A meeting of gentlemen interested in securing an electric railway between Thamesville, Bridgetown and Rondeau Park was held here, and it was decided to apply for a charter as soon as the necessary funds could be secured.

KENOSHA, WIS.—President Calkins of the City Council, who is acting mayor, has vetoed the ordinance passed October 24 granting the Milwaukee,

Racine & Kenosha Electric Railway Company a franchise to construct its road through the city of Kenosha.

VICTORIA, B. C.—On behalf of a Victoria syndicate Messrs. W. Jensen and S. Goodacre give notice of application for incorporation of the Hardy Tramway Company to build an electric railway from Hardy Bay to Cold Bay, Yuatsino Sound, a distance of 8 miles.

BOSTON, MASS.—The railroad commissioners have authorized an additional issue of $100,000 stock and $50,000 5 per cent. twenty-year bonds by the West Roxbury & Roslindale Street Railway Company for the purpose of funding the floating debt and for extensions and equipment.

BALTIMORE, MD.—The Baltimore Traction Company has declared a final dividend of about 1½ per cent. This winds up the affairs of the company and distributes what was left of its assets after the absorption of the property by the Consolidated Railway, formed by merging the City & Suburban and the Traction companies. The dividend is payable on stock of record of June 30, 1897.

NEW YORK, N. Y.—A Brooklyn newspaper is authority for the statement that the deal between the Brooklyn Rapid Transit Company and the Nassau Electric Railroad Company, which has been talked of a great deal recently, was consummated on the afternoon of November 22, and that the formal papers in the matter were signed in Manhattan that same afternoon. Under this arrangement the Rapid Transit Company acquires the control of the Nassau system.

EAST LIVERPOOL, OHIO.—A syndicate of New York, Philadelphia and Chicago men will build an electric freight road over the Ohio River hills from this city, 18 miles to Lisbon, the county seat. This city is to raise $60,000 bonus, the subscribers to be reimbursed by freight traffic certificates. Already $10,000 has been subscribed. In Madison township lies the largest undeveloped coal fields in the State. The syndicate has obtained options on 12,000 acres of coal, and will mine coal by electricity.

WEST CHESTER, PA.—The Pennsylvania Railroad Company has served an injunction on the Philadelphia, Castle Rock & West Chester Trolley Line Company, to restrain the latter from crossing its road by using a bridge on Gay Street, the bridge having been built by the Pennsylvania Railroad Company several years ago. The tracks of the trolley line are now at the eastern line of the town, and but for this legal procedure would have been laid in the town inside of a few days. The borough council has been appealed to by the defendant, and the matter is resting there for the present.

NEW YORK, N. Y.—The Fort George & Eleventh Avenue Railroad Company has been incorporated with a capital stock of $3,000,000. The directors are John T. Little, Jr., Ambrose F. McCabe, Fred C. Garrick, Frank F. Ogston and Sharon Graham, of New York City; Clement McCumming, of Yonkers; Charles A. Gilbert, of White Plains; William A. Dibbs, of Brooklyn, and D. C. Moorehead, of Jamaica. This company represents the consolidated interests of the North End Street Railway Company, the Fort George & Eleventh Avenue Railroad Company and the Fort George Extension Railway Company.

LANSDALE, PA.—A plan is on foot to connect Doylestown with the upper end of Bucks County by means of a trolley road from the county seat to Perkasie, Sellersville and Quakertown. At the latter place it is proposed to connect with the Quakertown and Richlandtown trolley. The borough council of Perkasie has passed an ordinance on first reading granting a franchise for the laying of tracks in the borough. The Sellersville officials have done likewise. The distance from Quakertown to Doylestown is about eighteen miles. The cost of the line is estimated at $8000 per mile.

NEW ORLEANS, LA.—The Street Railway Employees' Association is planning for an innovation in connection with the carnival that promises to add a very interesting feature. It is intended to give a carnival parade of street cars. The various car barns are taking up the matter, and a committee has been appointed from each of the seven stations. There will probably be two cars from each station and one gotten up by the traction management. These cars will be lighted with about 1000 lights, which will make a magnificent display, as the largest number ever put on a car here is 350. The seats will be taken out of summer cars and they will be made into floats.

WILKESBARRE, PA.—A trolley from Philadelphia to Delaware Water Gap, and probably Stroudsburg, is a possibility for the coming year. Capitalists are securing the right of way from Bethlehem to Nazareth, a distance of 8 miles, for an electric railway. After this line is completed it is understood the road will be extended 12 miles to Wind Gap, Pen Argyl and Bangor, and from there 12 miles to Portland and Delaware Water Gap. The near future will, therefore, see a direct communication by electric railway between Philadelphia and the Delaware Water Gap, a distance of over 80 miles. When this is realized it is proposed to run through electric cars from Bethlehem to Philadelphia, and from Bethlehem to Delaware Water Gap.

NEW YORK, N. Y.—Borough President Edward M. Grout, of Brooklyn, has submitted the following proposed ordinance to the Municipal Assembly for adoption: No street surface railroad company shall, between October 1 and May 1 of each year, use upon the streets of the city any street surface cars which are open on the sides, or which have doors on the sides thereof, under a penalty of $50 for each and every offense. The proposed measure is directed against the new combination cars in use on the lines of the Nassau Electric Railroad, which have been complained of as unfit for use in cold weather. There was a public hearing on the matter on November 19, at which President Grout was authorized to offer the above resolution to the Municipal Assembly.

HARTFORD, CONN.—The fourth annual meeting of the Connecticut Street Railroad Association was held in the offices of the Fair Haven & Westville road, New Haven, on November 16. Only routine business was transacted, and officers were elected as follows: President, Henry S. Parmelee, Fair Haven & Westville Railroad Company; vice-president, Congressman E. J. Hill, Norwalk Street Railroad Company; treasurer, E. S. Goodrich, Hartford Street Railway Company; secretary, B. W. Porter, Derby Street Railroad Company. The executive board for the year was elected as follows: President Parmelee, Vice-President E. J. Hill, A. M. Young, Waterbury Traction Company; C. S. Treadway, Bristol & Plainville Tramway Company; A. W. Mather, Central & Electric Railway Company, New Britain.

AUGUSTA, ME.—The electric railroads of this State have not all prospered, as the reports of the various companies indicate. The Bangor, Camden & Winterport Company reports a deficit of $96.40, after paying operating expenses, interest and other charges. The Bangor Street Railway shows a net income from operation of $11,127. After paying interest and taxes a deficit of $1660 remains. The deficit last year was over $11,000. The Bath Street Railway shows a net income from operation of $71,132. A dividend of 2½ per cent. on the preferred stock was paid during the year. On June 30 a surplus of $1893 remained. The Calais Street Railway reports a net income from operation of $4743, and after paying interest charges and taxes a deficit of $1786 remains. This, however, was a reduction of nearly $8000 as compared with last year's deficit. The Portland Railroad shows a net income from operation of $94,568. After paying interest charges there remained a net divisible income of $63,049, and after paying 6 per cent. dividend on the common stock there remains a surplus of $33,391, which, added to that carried from last year, makes the total amount $54,397. Deducted from this, however, is $29,334 for profit and loss, construction, equipment, etc., leaving the surplus June 30, $25,053.

Educational Notes.

ANNUAL INSPECTION TRIP.—During the week ending November 19 the annual inspection trip was made by the senior classes in electrical and mechanical engineering of the University of Wisconsin, Madison, Wis. The places visited were Cleveland, Pittsburg and Wheeling, and the plants of the following named concerns were visited: The Walker Company, the National Carbon Company, the Cleveland City Illuminating Company, the Cleveland & Painesville Electric Railway, the Cleveland Twist Drill Company, Warner & Swasey, Westinghouse Electric & Manufacturing Company, the Westinghouse Air Brake Company, Jones & Laughlin, the Homestead Mills and the Crescent Steel Company.

THE ELECTRICAL COURSES of the United Correspondence Schools, 156 Fifth Avenue, New York, it is stated, are giving satisfaction and are winning much popularity. There are two electric station engineering courses. It is stated that large numbers of station engineers, dynamo tenders, oilers, winders, draughtsmen, etc., have taken advantage of these courses, and as a result have secured more satisfactory positions and increased salaries. These schools also offer the following electrical courses: complete electrical engineering, electric lighting, electric railways, telegraph, telephone and electroplating, besides courses in mechanical, steam, civil and sanitary engineering. The schools will be pleased to send free a copy of their Circular F to any one on application.

Legal Note.

METER PATENTS.—Some two years ago suit was begun by the Westinghouse Electric & Manufacturing Company against the Citizens Lighting Company, of Brooklyn, N. Y., under two of the Shallenberger meter patents issued August 14, 1888, and numbered 388,003 and 388,004. The suit was directed specifically against the Scheeffer meter put upon the market by the Diamond Electric Company, of Peoria, Ill. Later—that is to say in June, 1897—other suits were brought against the same apparatus by the Tesla Electric Company and the Thomson-Houston Electric Company, respectively, under Tesla's transmission patents No. 511,559 and 511,560, December 26, 1893, and also under Elihu Thomson's electric meter patent No. 448,894, March 24, 1891. On November 28 decrees were entered in all the above mentioned suits, and the defendants were enjoined from further infringement of the said patents.

Personal Notes.

PROF. S. H. SHORT on December 1 resigned his position as second vice-president of the Walker Company. It is stated that he contemplates taking a trip abroad.

MR. E. F. PECK, who has been secretary of the Kings County Electric Light & Power Company, of Brooklyn, has been appointed assistant general superintendent of the same company.

MR. W. S. BARSTOW, who was general superintendent of the Edison Electric Illuminating Company, of Brooklyn, has received the appointment of general manager of the Kings County Electric Light & Power Company, which recently absorbed the Edison Company.

MR. A. A. THRESHER, of the Thresher Electric Company, Dayton, Ohio, visited New York on November 23, and hurried back again to Dayton to attend to the large line of work now being carried on by the company in power-distributing plants, especially motor-driven printing establishments.

Trade and Industrial Notes.

THE ROYAL ELECTRIC COMPANY, of Peoria, Ill., has just issued circulars describing its new line of alternating current generators and transformers. Copies will be gladly furnished to the trade.

THE CLEVELAND TWIST DRILL COMPANY, Cleveland, Ohio, informs The Electrical World that it was awarded the Gold Medal at the Trans-Mississippi and International Exposition held at Omaha.

THE UTICA ELECTRICAL MANUFACTURING & SUPPLY COMPANY, Utica, N. Y., has closed a contract with the L. B. Parker Lumber Mills, Parkers, N. Y., for a 150-light plant complete, with switchboard, dynamo, wiring, etc.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., in Circular No. 46 describes the chloride accumulator plant in the Commercial Cable Building, New York City. The subject is well illustrated. This plant was described in The Electrical World of November 6, 1897.

"THE REEVES" WOOD-SPLIT PULLEY.—Messrs. Patterson, Gottfried & Hunter, Ltd., 146-150 Centre Street, New York, have just issued an illustrated catalogue and price-list of "The Reeves" wood-split pulley. Some valuable information is given in this small pamphlet, and all those interested in such matters should obtain a copy.

A HIGH-TENSION STORAGE BATTERY.—Improvements in the continuous pole of storage-battery plates, the negative of one cell being on its other side the positive of the next cell, designed by N. H. Edgerton, have been covered in a patent No. 614,539, issued November 22. An illustrated description of this battery appeared in THE ELECTRICAL WORLD of April 23, 1898.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, Ohio, reports meeting with a satisfactory demand for its new motor for direct connection to machine tools, printing presses, etc., which is described and illustrated elsewhere in this issue. A number of important orders have been filled for these machines for such uses, among the tools thus driven being some heavy punches.

THE BERLIN IRON BRIDGE COMPANY, East Berlin, Conn., is erecting for the Waterbury Manufacturing Company, Waterbury, Conn., a new blacksmith shop, which will be of fireproof construction throughout. The roof has steel trusses supporting the covering of corrugated iron lined with the Berlin Company's patent anti-condensation lining. The building is about 40 feet square.

MR. HENRY B. CUTTER, president and general manager of the Cutter Electrical & Manufacturing Company, Philadelphia, Pa., was in New York during the past week. In addition to its well-known specialties, "I-T-E" circuit breakers and "C. S." flush switches, this company has just begun the manufacture of rheostats, an illustrated description of which is published elsewhere in this issue.

MR. HERBERT B. COHO, manager of the New York office of the Eddy Electric Manufacturing Company, reports sales to the International Manufacturing Company, Electric Vehicle Company, Benjamin Eastwood, Paterson, N. J., and the Watson Machine Works, Paterson, N. J.; also a number of small equipments. The Eddy standard for excellence is maintained. Friends of the company will be welcomed at its new office, No. 143 Liberty Street.

AN IMPROVED TRANSFORMER STAMPING.—A method of bending plain rectangular plates into L-shaped and U-shaped stampings which may be readily stacked up to form the magnetic circuits of core-type transformers has been patented by Dugald C. and William B. Jackson, in patent No. 614,474, issued November 22, 1898. One-half of the rights has been assigned to William D. and James W. Packard, of Warren, Ohio.

THE CHAPMAN VOLTAGE REGULATOR.—Patent No. 613,853 was issued to Mr. W. H. Chapman, November 8, 1898, and assigned to the Belknap Motor Company, Portland, Me., covering improvements on the Chapman regulator. The improvements provide a more direct application of the power of the working solenoid to the contact slider of the rheostat, and arrange the retarding device so that it may be adjusted while the regulator is in service.

THE ELECTRIC APPLIANCE COMPANY'S new catalogue of telephone apparatus and telephone construction material, No. 14, the company reports, is being very well received by the telephone trade, and, judging from the orders for telephone material that are coming in, is being very extensively used. The Electric Appliance Company claims that this is the most complete catalogue of telephone supplies that has yet been issued. It will be pleased to supply copies free of charge to the telephone trade.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., has during the past summer made an extension to its pencil factory, 40x90 feet and three stories high. The machinery is driven by electric power from the generator in the main factory. No expense has been spared in the equipment of this addition in the way of up-to-date elevators, furnaces, etc., and some time during 1899 various other additions to the extensive plant of the company will be built. This concern was established in 1827, and its products go into every known field of industry.

THE KRAJEWSKI-PESANT COMPANY announces that it has opened its wholesale and retail store in Havana, Cuba, at Calle O'Reilly 150, and is handling all kinds of machinery, especially electrical appliances. The company is represented in Havana by Mr. Norman H. Schneider, who was with the export department of the Western Electric Company, New York, for a number of years. The company is sole agent for a number of American firms and also for the British General Electric Company. Mr. Schneider reports having several plants to overhaul and put into running order.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, of St. Louis, Mo., has recently completed and is ready to furnish a device by means of which large church organs can be operated satisfactorily with the use of alternating current motors. This special adaptation of alternating current motors has been developed in response to numerous inquiries extending over a number of years, and the company believes that it is the only device on the market by which churches, placed beyond the reach of direct current, can operate their organ bellows with an electric motor. The Emerson Company would be glad to receive inquiries from interested parties.

"ENCLOSED ARC LAMPS" is the title of the latest pamphlet issued from the General Electric press. It deals with the different types of enclosed arc lamps manufactured by the General Electric Company for direct and alternating current circuits, indoor and outdoor lamps, marine lamps, miniature lamps, power circuit lamps, series enclosed lamps and single globe and double globe lamps. Each type is well illustrated, and the object of its design and its advantages set forth in language unhampered by abstruse technical expressions. It is written for the information of the general consumer as well as the electrician. The pamphlet will be sent to persons interested on application to any of the sales offices of the General Electric Company.

THE VICTOR TELEPHONE & MANUFACTURING COMPANY, Chicago, Ill., now has orders in its factory for about 1200 drops, the filling of which requires overtime work. The company reports that its goods are meeting with unpredecented favor. Among the exchanges installed during the past month was one of 100 capacity at Bunceton, Mo. The company has just issued its 1899 catalogue, which will be found of great interest to telephone people. It is a unique production of its kind, and gives a description and illustrations of the various styles of instruments made by this enterprising company. A copy will be sent to any one interested in telephone exchange work upon application to the company, whose headquarters are at 166-174 South Clinton Street.

A NEW OPEN-CIRCUIT BATTERY.—An improvement in batteries of the Leclanché type was the subject of patent No. 614,759, issued to Mr. Charles T. Richmond, November 22, 1898, and assigned to the National Carbon Company, of Cleveland, Ohio. The improvement consists in a porcelain cover with downwardly extending screw-threaded projection, on which may be screwed an internally threaded porous cup containing the usual carbon pole and depolarizing material. The purpose of the construction is to make the depolarizer readily renewable by the user, so that the only depreciating parts of the battery are the zinc, the sal ammoniac and the depolarizer, the porous cup and carbon not being wasted at every renewal of the depolarizer.

"A BIRD'S-EYE VIEW" of the business of the Westinghouse Machine Company, Pittsburg, Pa., is presented to human eyes in a little circular just issued by that concern. The object of the circular is to furnish a brief but comprehensive index to the character and extent of this company's business. The various types of Westinghouse engines are artistically illustrated, the principal features of each being briefly described. Among them may be especially noted the Metropolitan type, which are built in sizes of 1000 horsepower and upward, and the Westinghouse gas engine. The latter type of engine is fully described and illustrated on another page in this issue. The Roney mechanical stoker, mechanical draft, economizers, the steam loop and ice-making and refrigerating machinery also constitute subjects that are also described and illustrated.

THE WESTERN ELECTRIC COMPANY has recently issued Bulletin No. 11,001, in which are illustrated the S. K. C. transformers for lighting and power. This company is the exclusive Western agent for all the apparatus manufactured by the Stanley Electric Manufacturing Company, and carries a full stock of transformers in Chicago for immediate shipment. The S. K. C. transformers are built for any purpose and any voltage. There is said to be no aging of iron. In regard to the lighting transformers, the primaries and secondaries are interchangeable and fuse boxes may be used on the transformers or elsewhere. The larger transformers are made of the following types: Self-ventilating, air blast, oil insulated and oil-insulated water-cooled. Regulating transformers are manufactured for the independent control of the voltage of circuits involving the introduction of low resistance. A copy of the bulletin will be mailed to anyone who has not received a copy.

MESSRS. THOMPSON, SON & CO., 107 Liberty Street, New York City, who are well known in the machinery trade, have recently embarked in the business of dealing in second-hand electrical apparatus. The November bargain sheet of this firm includes various lots of standard high-grade and special lamps, 110-125-volt incandescent dynamos of all makes, a long line of motors of various makes, alternating generators and arc dynamos. The firm also has arc motors, power generators, incandescent arc lamps, carbons, transformers, armatures and commutators, switchboards, etc., etc. It is continually buying dynamos, railway generators, railway motors, transformers, arc lamps, motor and trail cars, engines and other equipment, and anyone interested who desires to secure bargains in these lines will do well to communicate with the house. The firm also makes repairs of all kinds, including rewinding armatures, fields, the rebuilding of commutators, railway motors, etc., etc.

THE AMERICAN ELECTRIC HEATING CORPORATION, Cambridgeport, Mass., has been doing an excellent business for some time past, and all indications are that these conditions will continue, as orders are constantly increasing. The larger central stations and supply houses are the company's best customers. The Consolidated Traction Company, of Baltimore, Md., has recently awarded to this company, after severe competitive tests, the order for the equipment of its cars with "American" heaters. All the Boston Subway ticket offices are equipped with "American" air heaters, as are also the ticket offices of Keith's Theatre. The Hudson River State Hospital, at Poughkeepsie, N. Y., has equipped its laundry department with fifty "American" irons; the New York hospital ship "Bay State" is equipped with air heaters, and also with kitchen heating specialties of the "American" type, and last, but by no means least, an order has just been received from abroad for the electric heating equipment of the large steamer "Oceanic," now being built on the Clyde. This order was secured after most exhaustive tests with foreign and other electric heating apparatus, a model stateroom having been specially built for the test. These are but a few of the many recent orders received by the company.

CHRISTENING A NEW LAMP.—It will be remembered that the Warren Electric & Specialty Company, Warren, Ohio, some time ago organized a contest for the naming of its new incandescent lamp, which the company thought was none too good for the best name that bright minds could conceive. It offered prizes for the names that should be decided by the judges to be the best for the new lamp. The judges have rendered their decision, and the following is a list of the successful contestants, with the names for the lamp and the value of the prizes: First prize, $50, "Peerless," Joe E. Calloway, Pueblo, Col.; John C. Watson, Charlotte, N. C.; J. W. Freeman, Joplin, Mo. Second prize, $30, "Wesco," K. W. Mansfield, South Norwalk, Conn.; Gugler Electric Company, Minneapolis, Minn.; J. E. Calloway, Pueblo, Col.; H. P. Ayer, Portland, Me.; J. S. Daily, Chillicoothe, Ill.; New Orleans Electric Company, New Orleans, L.; C. J. Wetsel, Chicopee Falls, Mass. Third prize, $20, "Liberty," W. H. Schott, Chicago, Ill.; J. E. Calloway, Pueblo, Col.; A. D. Scatcherd, Batavia, N. Y.; C. Frankish, Ontario, Cal.; Phillip Hickley, Chicago, Ill. Fourth prize, $10, "Aladdin," "Aurora," "Eclipse," "Encore," Thos. Day Company, San Francisco, Cal.; D. A. Gill, Kansas City, Mo.; Lemuel K. Cushing, Chicago, Ill.; H. L. Brintnall, Saginaw, Mich.

Business Notice.

THE ILLUSTRATIONS in this issue were made by the Photo-Engraving Company, 9-15 Murray Street, New York City.

UNITED STATES PATENTS ISSUED NOVEMBER 22, 1898.

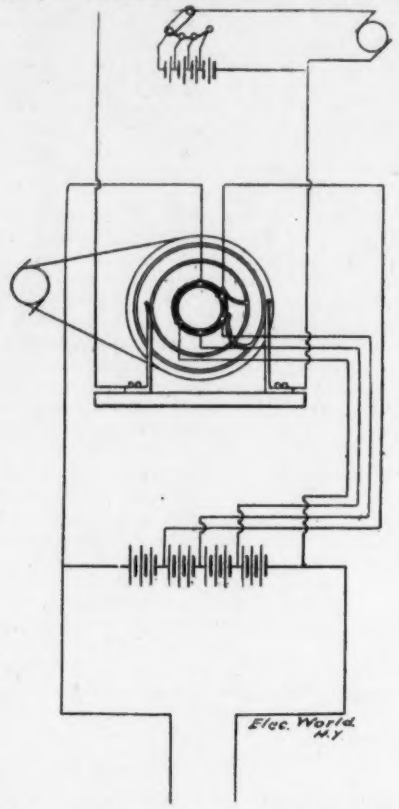
[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

614,453. METHOD OF MANUFACTURING ELECTRIC CABLES; S. Z. de Ferranti, of Hollinwood, England. App. filed Dec. 28, 1897. The method of manufacturing electric cables, which consists in first forming a circular stranded conductor to the shape of a part of a circle in cross section, insulating said conductors, and lastly laying a number of such conductors together spirally forming an approximately cylindrical cable.

614,462. COMMUTATOR; J. R. Grindrod, of Lynn, Mass. App. filed Feb. 6, 1897. As an article of manufacture, a commutator composed of a number of segments separated from each other by insulation, and provided with means whereby they may be secured to the shell; a finished or partly finished outer periphery for making contact with brushes, and means for securing the segments in place during transit and mounting, but which is removed before the commutator is used.

614,472. POTENTIAL SWITCH; J. D. Ihlder, of Yonkers, N. Y. App. filed Aug. 5, 1897. A potential switch the coils of which are wound in opposition, having an adjustable core piece, substantially as described.

614,474. TRANSFORMER STAMPING; D. C. Jackson, of Madison, Wis., and W. B. Jackson, of Grand Rapids, Mich. App. filed Sept. 27, 1897. A transformer stamping composed of a strip of metal folded on itself at an angle, substantially as described.



No. 614,571.—Transformer System and Apparatus.

614,484. HANGER FOR ELECTRIC LAMPS; J. E. Mayo, of Belvidere, Ill. In a hanger for electric lamps, in combination, a circular vertical socket opening downward, a spring on the socket normally closing a circuit, a stud fast to the spring and projecting inward, through a transverse opening, in the socket, into the vertical opening therein, and a stem adapted to enter the socket and, by outward pressure upon the stud, open the circuit, substantially as described.

614,528. ELECTRIC LIGHTING GAS BURNER; J. M. Anck, of Philadelphia, Pa. App. filed October 19, 1897. In an electric lighting gas burner, the combination of a fixed electrode, a valve stem, a plate mounted on said stem, a lever also mounted thereon, insulation interposed between said plate and lever and between said lever and stem, an electrode carried by said lever, a lever pivoted to said plate, and means for moving said pivoted lever into contact with the first-mentioned lever.

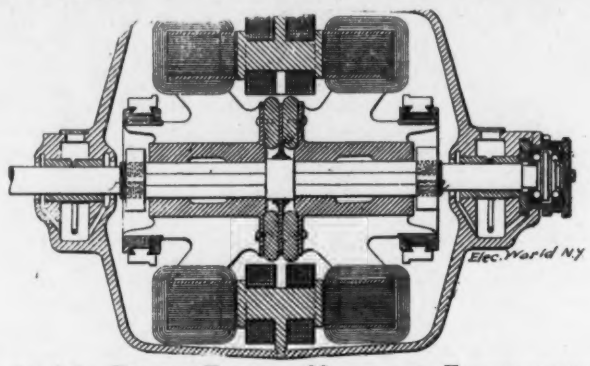
614,539. SECONDARY BATTERY; N. H. Edgerton, of Philadelphia, Pa. App. filed Sept. 14, 1897. A secondary battery having a series of superposed plates, each consisting of a zinc element, a coating of lead applied thereto, said lead having a layer of red lead superimposed thereupon, and granulated non-conducting charcoal supported upon said red lead.

614,571. TRANSFORMER SYSTEM AND APPARATUS; A. Muller, of Hagen, Germany. App. filed July 30, 1897. The combination with two circuits for carrying currents of different tension, a commutator interposed in said circuits, groups of storage cells connected with the commutator to be charged in parallel and discharged in series, and to be charged in series and discharged in parallel, respectively, when receiving current from or supplying current to said commutator; of a storage battery and a spark arrester always in circuit with the low-tension circuit, and connected through the commutator with the group of storage cells.

614,597. MEANS FOR CONVEYING CABLES, WIRES OR THE LIKE THROUGH UNDERGROUND CONDUITS; J. Wrigley, of Elmira, N. Y. App. filed June 14, 1898. A flexible shafting, consisting of two coils wound closely upon each other, but in opposite direction, in combination with one or more guide carriages removably arranged on the outer coil, substantially as described.

614,608. DYNAMO-ELECTRIC MACHINE OR ELECTROMOTOR; E. Cantono, of Pavie, Italy. App. filed Dec. 16, 1897. The combination with an electromagnet, consisting of cores and ring, and a shell of casing consisting of opposite cups between which said ring is clamped.

614,686. MAGNETIC CUT-OUT; L. Andrews, of Hastings, England. App. filed Nov. 29, 1897. A magnetic cut-out for each of two or more electric-

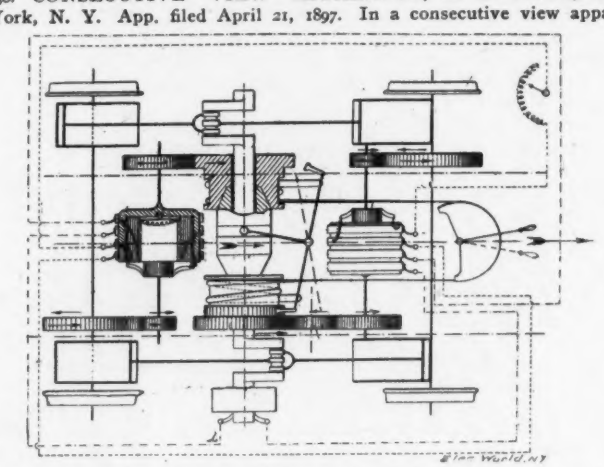


No. 614,608.—Dynamo-Electric Machine or Electromotor.

current generators, consisting of a core surrounded by a continuous winding in series with the generator, a shunt-winding part of which is in the same direction as the series of winding and the other part in the reverse direction, and a switch controlled by said core, substantially as described.

614,709. MEANS FOR DRIVING RAILWAY, TRAMWAY OR AUTOMOBILE CARS; G. Dupont and M. Johannet, of Paris, France. App. filed Oct. 29, 1896. In a motor vehicle, the combination with a front and a rear axle of two countershafts, one geared to each axle, a main shaft geared to the two countershafts, a field magnet on each countershaft, a single circuit including the field coils of both dynamos, a single circuit, including the two armature windings, and a variable resistance included in the armature circuit, substantially as described.

614,738. CONSECUTIVE VIEW APPARATUS; H. N. Marvin, of New York, N. Y. App. filed April 21, 1897. In a consecutive view apparatus,



No. 614,709.—Means for Driving Railway, Tramway, or Automobile Cars.

the combination with mechanism for moving a series of views through the field of the apparatus, of a driving device for said mechanism adapted to be operated by an observer, means for illuminating the views, and an automatic cut-off device, operated when said driving device is released by the observer for stopping the illumination of the apparatus, substantially as described.

614,759. GALVANIC BATTERY; C. T. Richmond, of Cleveland, Ohio. App. filed July 18, 1898. In a galvanic battery, the combination of a jar, and a cover therefor made of insulating material, and having an integral threaded boss on its under side and a hole through said boss and cover, with a clay porous cup internally threaded at its open upper end, which cup is screwed onto said boss; a carbon electrode in said cup having a stem which extends up through said hole, and a zinc electrode having a stem which projects through a hole in the cover, and is supported by said cover, and depolarizing material in said clay cup, substantially as described.